POLARAD

PROVEN RELIABILITY

HANDBOOK
OF
OPERATING INSTRUCTIONS

MICROWAVE
SIGNAL GENERATORS
MODEL MSG-1
MODEL MSG-2A

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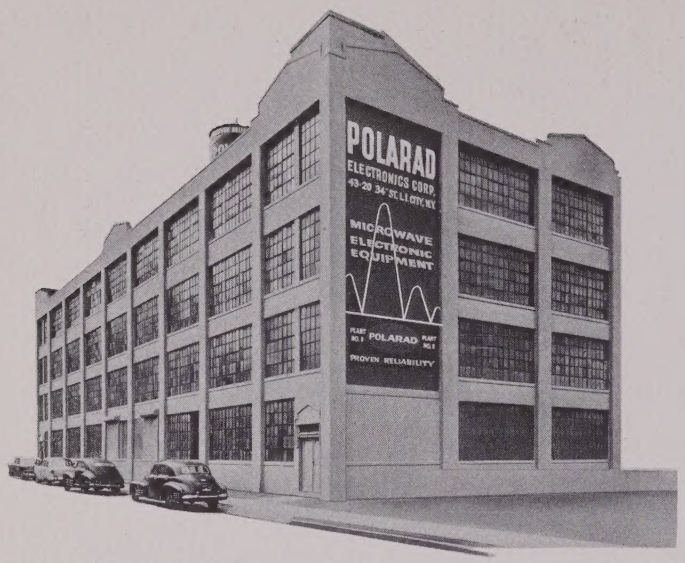

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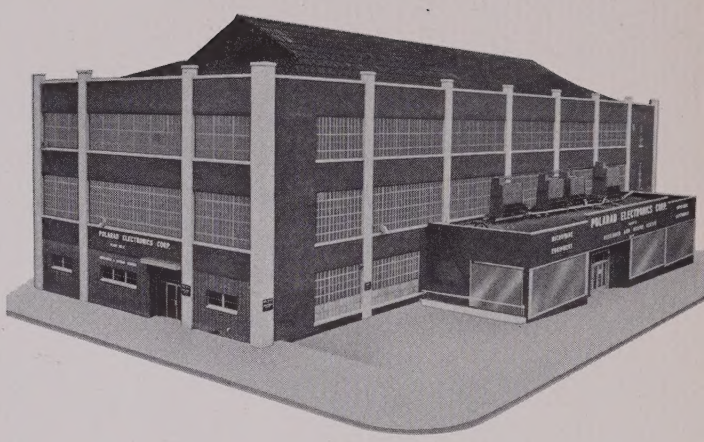

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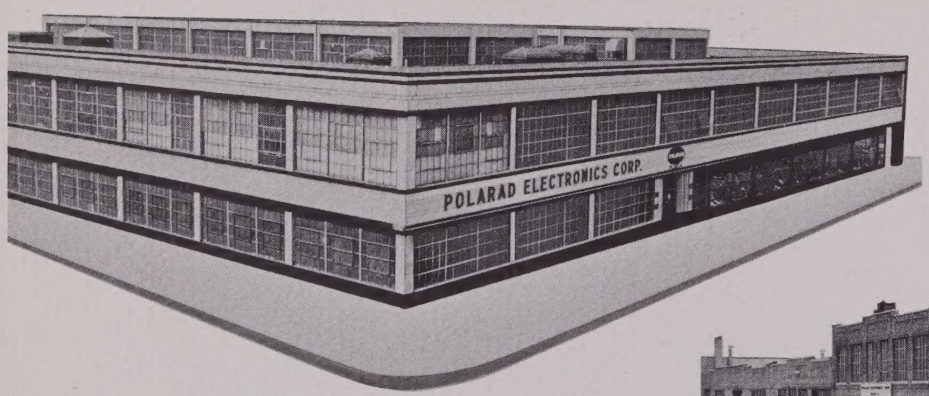

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INSTRUCTION MANUAL

MICROWAVE
SIGNAL GENERATORS
MODEL MSG-1
MODEL MSG-2A

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SERIAL NO.
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Figure 1. Microwave Signal Generator

SECTION 1

GENERAL DESCRIPTION

1-1. SCOPE OF MANUAL

This instruction manual describes Microwave Signal Generators Models MSG-1, (Serial No. 211 and up), and MSG-2A, (Serial No. 221 and up), manufactured by the Polarad Electronics Corporation, Long Island City 1, New York. The manual contains a listing of the physical and electrical characteristics, instructions for operating and maintaining the equipment, and a description of the principles of operation. Figure 1 is a photograph of the equipment.

1-2. FUNCTIONS OF MICROWAVE SIGNAL GENERATORS

Microwave Signal Generators Models MSG-1 and MSG-2A are designed for testing and adjusting radio and radar systems that operate in the frequency range 950 to 4,600 megacycles per second (mcs), and for making laboratory measurements. The signal generators supply delayed and undelayed video pulse signals, and low-power continuous wave, pulse-modulated or frequency-modulated radio-frequency test signals of known frequency and power level.

1-3. TECHNICAL CHARACTERISTICS

Power input	115 v ±10%, 50 to 60 cps, or 230 v ±10%, 50 to 60 cps.
Frequency range and accuracy	MSG-1: 950 to 2,400 mcs; MSG-2A: 2,000 to 4,600 mcs: ±1%; (MSG-2, Serial No. 221-320: 2,150 to 4,600 mcs).
Power output	1 mw.
Attenuator range	0 to -127 db
Attenuator output accuracy	±2 db
Output impedance	50 ohms.
Type of emission	Cw, pulse, square wave, or fm.
Tube complement: MSG-1	Ten 12AT7; two 6AK6; one 6AR6; one 6AS7G; three 6AU6; one 6X4; two 5R4GY; one 5651; one 5837; two OA2; four OB2.
MSG-2	Ten 12AT7; two 6AK6; one 6AR6; one 6AS7G; three 6AU6; one 6X4; two 5R4GY; one 5651; one 5836; three OA2; three OB2.
Modulation capability	Pulse modulation from a self-contained pulse generator or from an external modulation source; frequency modulation from a self-contained sawtooth generator, as described below; square-wave modulation from a self-contained square-wave generator.
Internal pulse modulation	a. Repetition rate adjustable from 40 to 4,000 pps. b. Pulse width adjustable from 0.5 to 10 usec measured between points on initial rise and decay which are 50% of the largest amplitude of the initial rise. c. Pulse rise time less than 0.5 usec, as measured from 10% to 90% of full amplitude. d. Pulse decay time less than 0.5 usec, as measured from 90% to 10% of full amplitude.

Internal square-wave modulation. . . . . Repetition rate adjustable from 40 to 4,000 pps.

External pulse modulation . . . . . a. Required pulse amplitude between 15 and 70 volts, positive or negative polarity.
b. Required pulse width between 0.5 and 2,500 usec.
c. Required pulse spacing between 1 and 2,500 usec.
d. Required pulse rise and decay times between 0.1 and 1 usec, as measured between 10% and 90% of full amplitude.
e. Required pulse rate 40 to 4,000 pps.

Internal fm . . . . . a. Linear sawtooth type.
b. Sweep rate adjustable from 40 to 4,000 sweeps per second.
c. Deviation adjustable from zero to at least ±2.5 mc.
d. Power output of fm test signal adjustable from 0 to -127 dbm. Maximum change in power output during a deviation up to ±2.5 mc is less than 3 db.

External sync sources:
(1) Sine wave . . . . . a. Required frequency between 40 and 4,000 cps.
b. Required amplitude between 5 and 50 volts rms.

(2) Pulse signal . . . . . a. Required repetition rate between 40 and 4,000 pps.
b. Required amplitude between 5 and 50 volts peak, positive or negative polarity.
c. Required pulse rise time between 0.1 and 1 usec.
d. Required pulse width between 0.5 and 5 usec.

Output synchronizing pulses,
Undelayed and delayed sync . . . . a. Positive polarity, between 25 and 100 volts pulse amplitude.
b. Pulse width between 0.5 and 5 usec.
c. Pulse rate between 40 and 4,000 pps, identical with rate of pulse-modulated rf test signal.
d. Pulse rise and decay times less than 1 usec.
e. Required load: 500 to 100,000 ohms resistance, shunted by 500 micromicrofarads or less capacitance.
f. Timing: Undelayed sync pulse occurs at approximately the same instant as the leading edge of the modulator trigger pulse (either internally generated or synchronized with an externally applied sync input signal). Delayed sync pulse delay is variable from 3 to 300 usec. Delay is measured from the leading edge of the modulator trigger pulse to the leading edge of the rf output signal.

Dimensions . . . . . 17 wide by 13-1/4 deep by 15-1/2 inches high.

Weight . . . . . 60 pounds uncrated.

SECTION 2
OPERATION

2-1. FUNCTION OF CONTROLS

Table 1 lists the panel designations of all operating controls, connectors, and their functions.

TABLE 1. OPERATING CONTROLS AND CONNECTORS

Control or Connector	Function
POWER ON-OFF switch	A double-pole, single-throw switch closes the circuit in the primary of the power transformers to apply a-c power.
Power Indicator	Red-lens indicator, glows when the POWER switch is ON and power is applied to the signal generator.
RF OSC. control and dial	Rotation of the control simultaneously drives the klystron cavity tuning mechanism, the frequency dial, and the repeller voltage tracking potentiometer to set the signal generator operating at the desired frequency. The dial is directly calibrated in kilomegacycles.
MODULATION SELECTOR	This six-position switch is rotated to its ZERO SET position to make the rf oscillator circuit inoperative, for the initial calibration procedure. After zero-setting the power level meter, through adjustment of ZERO SET control, the switch permits selection of cw, fm, or pulse modulation output, as desired. For pulse operation, the switch permits selection of the internal pulse generator, an external positive modulating signal or an external negative modulating signal as the source for the rf oscillator pulse modulation.
ZERO SET	With MODULATION SELECTOR in its ZERO SET position, this potentiometer permits calibration of the internal power monitor bridge circuit, as indicated by deflection of the meter pointer to its ZERO position.
POWER SET	With MODULATION SELECTOR in its CW position, this control permits adjustment of the amount of rf current flowing through the power monitor bridge. When the meter pointer deflects to CAL. by adjustment of this control, the power level of signals at the RF OUTPUT jack can be read directly from the calibrated ATTENUATOR dial.
ATTENUATOR control and dial	This control mechanically drives the rf output attenuator and dial to control the rf output power. The upper portion of the dial is calibrated in decibels below one milliwatt across 50 ohms, resistive load, at the front panel RF OUTPUT receptacle. The lower portion of the dial is calibrated in millivolts and microvolts, as marked.
SYNC SELECTOR	This four-position switch is used to select the type of synchronizing signal (when used) applied to the self-contained modulator circuit. In its INT position, the modulator develops pulse, square-wave or sawtooth output, as determined by the setting of the MODULATION SELECTOR and PULSE WIDTH, without synchronization with external equipment. In its SIN position, the internal pulse or sawtooth generator may be synchronized with a sine wave sync signal from external equipment, with the signal applied to the front panel SYNC INPUT jack.

TABLE 1. OPERATING CONTROLS AND CONNECTORS (cont)

Control or Connector	Function
SYNC SELECTOR (cont)	In its - position, the internal pulse or sawtooth generator is synchronized with negative-polarity video pulses from external equipment, with the signal applied to the front panel SYNC INPUT jack. In its + position, the internal pulse or sawtooth generator is synchronized with positive polarity video pulses from external equipment, with the signal applied to the front panel SYNC INPUT jack.
RATE MULTIPLIER	This two-position switch is used to select the range of pulse repetition rate (with MODULATION SELECTOR in its INT position), and the range of sweep rate (with MODULATION SELECTOR in its FM position). In the X1 position of the RATE MULTIPLIER switch, a range of 40 to 400 pulses (sawtooth sweeps) per second is available; in the X10 position, a range of 400 to 4,000 pulses (sawtooth sweeps) per second is available.
PULSE RATE	This dual-potentiometer control is used to select the pulse repetition rate of the modulator, when MODULATION SELECTOR is in its INT position; and sawtooth sweep rate, when MODULATION SELECTOR is in its FM position. The rate is read directly from the calibrated panel markings when RATE MULTIPLIER is in its X1 position; pulse rate is ten times the calibrated panel markings when the RATE MULTIPLIER is in its X10 position.
FM AMPLITUDE	This control is operative only when MODULATION SELECTOR is set to its FM position. The control sets the magnitude of the sawtooth signal applied to the repeller of the reflex klystron oscillator. The range of frequency deviation available from this control is from zero (extreme counterclockwise setting) to at least ±2.5 mc.
PULSE DELAY	This control is operative when MODULATION SELECTOR is set to the INT or FM position. The control permits adjustment of the delay between the leading edge of the undelayed sync pulse and the leading edge of the rf output test signal over the range from 3 to 300 microseconds, but not greater than 75% of the pulse period. (See figure 2.)
PULSE WIDTH	This control is operative only when MODULATION SELECTOR is set to its INT position. The control permits adjustment, from 0.5 to 10 microseconds, of the pulse width of the rf test signal. This width is measured between points on the initial rise and decay which are 50% of the peak amplitude of the initial rise. A switch on the shaft control connects the square-wave generator to the klystron keying circuits in SQ. WAVE position.
EXT MOD receptacle	This receptacle permits the signal generator to be connected to a source of external modulating voltage. It is used only when MODULATION SELECTOR is set at EXT POS or EXT NEG position to correspond with the polarity of the applied external modulating signal.
SYNC INPUT receptacle	This receptacle is used when it is desired to synchronize the signal generator with a sine wave or pulse sync signal from external equipment. The MODULATION SELECTOR is placed in its FM or INT position to produce frequency-modulated or pulse-modulated output, as desired, and the SYNC SELECTOR to that panel designation which corresponds with the type of external sync signal applied.

TABLE 1. OPERATING CONTROLS AND CONNECTORS (cont)

Control or Connector	Function
UNDELAYED SYNC receptacle	This receptacle is used when it is desired to trigger external equipment with positive video pulses in synchronization with the leading edge of the modulator trigger pulse. The MODULATION SELECTOR must be in FM or INT position.
DELAYED SYNC receptacle	This receptacle is used when it is desired to trigger external equipment with positive video pulses delayed from the leading edge of the undelayed synchronizing pulse. The delay may be from 3 to 300 usec, up to 75% of the pulse period. The MODULATION SELECTOR must be in FM or INT position. See figure 2.

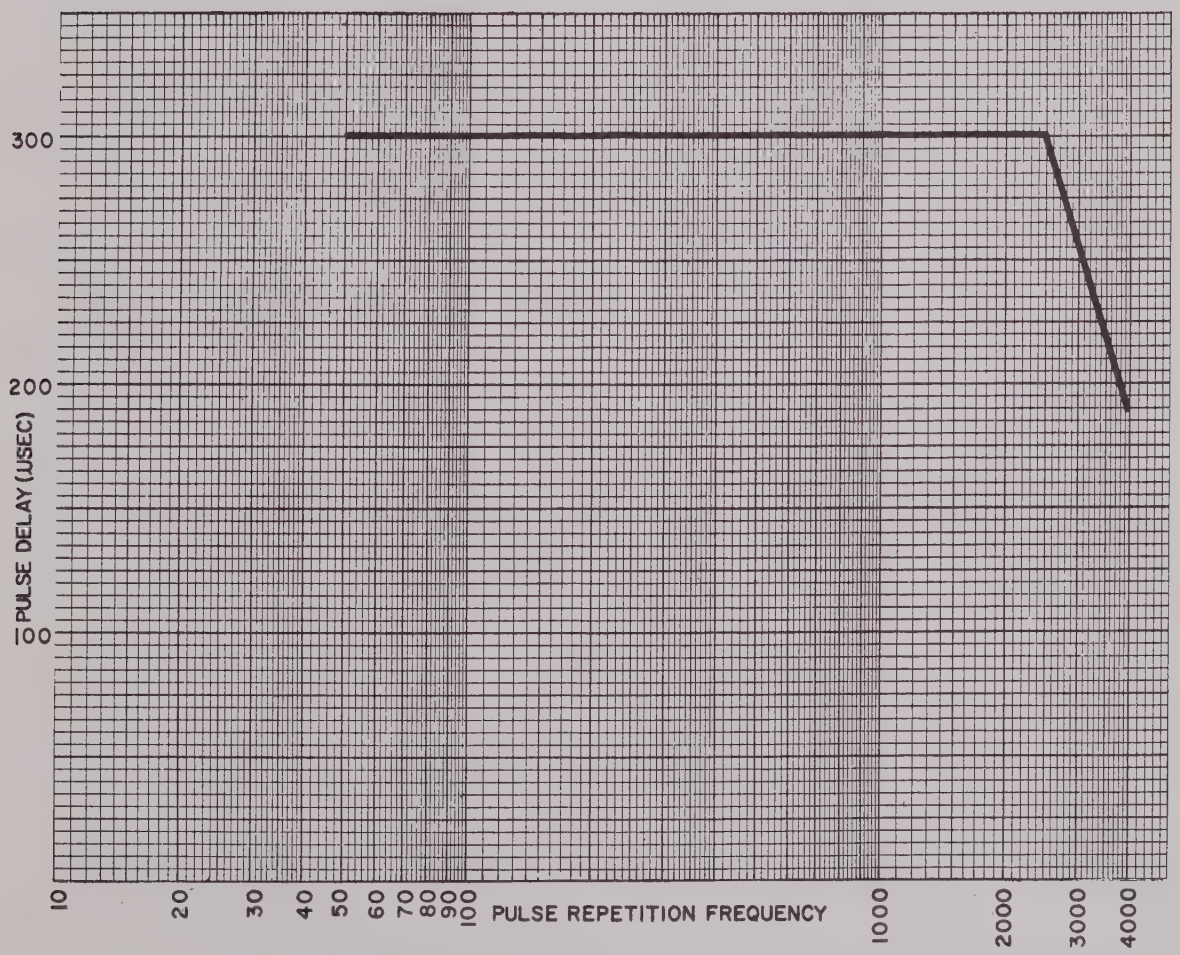


Figure 2. Maximum Pulse Delay versus Pulse Repetition Frequency

2-2. OPERATING INSTRUCTIONS

CAUTION

Before turning equipment power on, be sure to check TB6 to see if this terminal board is wired for the proper input voltage. See figure 11 or 12.

2-3. Calibrating the power output. To ascertain that the signal generator is in operating condition and to make sensitivity checks, it is necessary to calibrate the power output. To do so, proceed as follows:

a. Connect the POWER INPUT receptacle to a proper, 50-60 cps, single-phase power source.

b. Throw the POWER switch to the ON position. The front panel red indicator lamp should light.

c. Allow the generator to warm-up for at least 15 minutes.

d. Rotate the RF OSC knob until the frequency dial shows the desired operating frequency.

e. Turn the MODULATION SELECTOR to the ZERO SET position.

f. Adjust ZERO SET control until the pointer on the meter is at ZERO.

g. Turn the MODULATION SELECTOR to the CW position.

h. Adjust the large POWER SET knob until the pointer on the meter is at the CAL mark. The signal generator is now at the one-milliwatt power reference level for the frequency set in step d, above.

i. Rotate the ATTENUATOR knob until the attenuator dial is set to the desired value of rf signal level. The output level is expressed in decibels below one milliwatt, working into a resistive load of 50 ohms, on the top scale; and in either millivolts or microvolts, as marked on the lower scale.

NOTE

Whenever the setting of the frequency dial is changed, it is necessary to repeat the calibration procedure, as given above, in order to determine the power output.

2-4. Control settings. Control settings for the different outputs and their modulating and triggering voltages are given in table 2.

TABLE 2. CONTROL SETTINGS

OUTPUT		MODULATION SOURCE	CONNECTED AT	MODULATION SELECTOR SETTING	SYNC SELECTOR SETTING	PULSE WIDTH
RF	SYNC PULSE*					
1. CW	None	None	---	CW	---	---
2. Pulse Modulated	Delayed and Undelayed	Internal pulse generator	---	INT	INT	As required
	None	External	EXT MOD	EXT POS or EXT NEG**	---	---
	Delayed and Undelayed	External	SYNC IN	INT	-, + or SIN**	As required
3. Square-wave Modulated	Delayed and Undelayed	Internal square-wave generator	---	INT	INT	SQ. WAVE
4. FM	Delayed and Undelayed	Internal sawtooth (fm)generator***	---	FM	---	As required

NOTES

Figure 2 shows the maximum permissible setting of the PULSE DELAY control for pulse repetition rates within the pps range of the equipment. A delay setting greater than depicted by the curve will result in a false indication.

*Rate is controlled by an external modulation source. If internally modulated, the PULSE RATE and RATE MULTIPLIER controls determine the pulse repetition rate. Delay is set by PULSE DELAY control.

**Dependent upon type and polarity of external modulation.

***Sweep rate is controlled by settings of PULSE RATE and RATE MULTIPLIER controls. Deviation range (amplitude of applied sawtooth) is controlled by FM AMPLITUDE control.

SECTION 3

PRINCIPLES OF OPERATION

3-1. GENERAL

The basic principles of the Polarad Microwave Signal Generators may be understood from the block diagram of figure 3. The signal generators provide continuous-wave, pulse-modulated continuous-wave and frequency-modulated signals of known intensity and frequency in the ranges of 950 to 2,400 mc and 2,000 to 4,600 mc. Each signal generator consists essentially of an rf reflex klystron oscillator circuit, a modulator, a keyer circuit, a power-monitoring bridge circuit, and two self-contained power supplies.

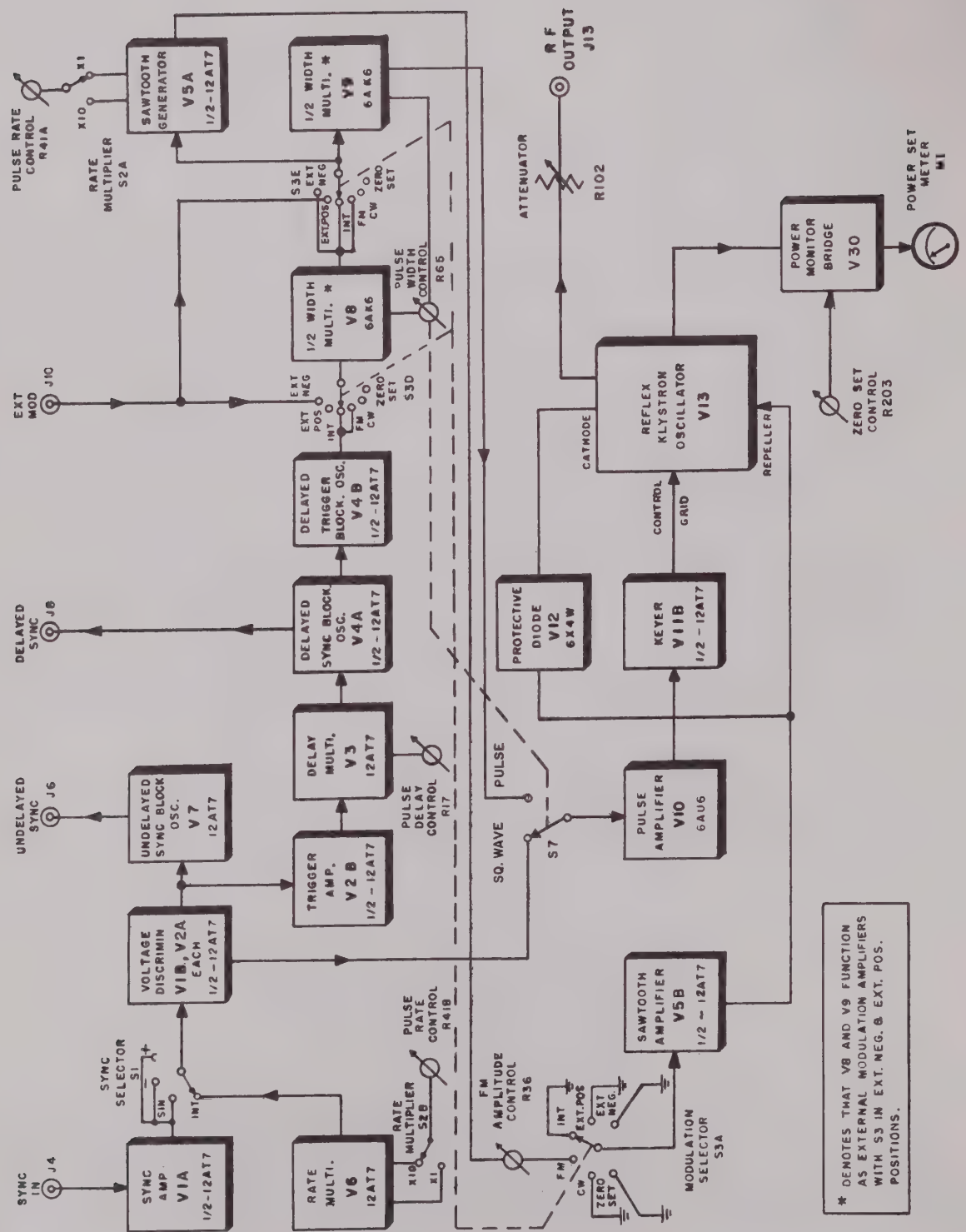


Figure 3. Signal Generator, Block Diagram

The function of the modulator is to generate a modulation voltage, either pulse, square wave, or sawtooth in waveform and to apply this voltage to the reflex klystron oscillator tube. When pulse or square wave modulation is used, the signal from the modulator is applied to the grid of the klystron tube via a pulse amplifier and keyer circuit. When frequency modulation is used, the sawtooth signal from the modulator is applied to the repeller electrode of the klystron tube directly. Provision is included for synchronizing the modulation voltage with an externally applied sine wave or pulse signal, of positive or negative polarity. When synchronization with an external source is not desired, the modulating voltage is generated by internal pulse or sawtooth waveform generator circuits. Provision is also included for making the internal modulator circuit inoperative, while an external pulse signal source is used to modulate the reflex klystron oscillator tube.

In addition to producing an rf test signal at the equipment front panel RF OUTPUT connector, the signal generator also produces video trigger signals for application to external equipment under measurement. At the UNDELAYED SYNC output jack, a positive polarity pulse of approximately one-microsecond duration, occurring coincident with the leading edge of the modulator trigger signal, is available. At the DELAYED SYNC output jack, a positive pulse of approximately one-microsecond duration, occurring almost coincident with the leading edge of the rf output test signal, is available. The setting of the front panel PULSE DELAY control permits a delay of between 3 and 300 microseconds (with pulse repetition frequencies from 40 to 2, 500 pulses per second) between the generation of the rf test signal and the modulator trigger signal. At pulse repetition frequencies higher than 2, 500 pps, the time delay is limited to 75% of the pulse period, as shown in figure 2. The setting of the front panel PULSE WIDTH controls permits adjustment of the pulse duration of the internally-modulated rf test signal from 0. 5 to 10 microseconds. During cw, fm, or pulse-modulated operation, a portion of the rf output from the reflex klystron oscillator tube is applied to a self-contained power monitor bridge circuit.

3-2. CW OPERATION

In cw operation MODULATION SELECTOR S3 is set to the CW position. Neither delayed nor undelayed sync outputs are available. To assure that no signal will be applied to the klystron oscillator, which provides the power output, the input signals to the sawtooth and trigger amplifiers are grounded, B+ is removed from the plate and screen of the width multivibrator and the pulse amplifier is made inoperative by disconnection from the minus 325 volt cathode supply.

3-3. KLYSTRON OSCILLATOR CIRCUIT

The klystron oscillator circuit uses a klystron reflex tube operating in an external resonant cavity to generate cw signals (figure 4). Rotation of the RF OSC control on the front panel changes the position of a movable non-contacting shorting plunger within the cavity to set the resonant frequency. Protective diode V12 is connected between the klystron repeller and cathode and serves to keep the repeller from going positive with respect to the cathode.

3-4. ATTENUATOR

The attenuator is used to reduce the output of the klystron oscillator a measured amount below the reference level of 1 milliwatt (0 dbm). The attenuator is controlled by the ATTENUATOR knob. Above and below the knob a dial indicator affords direct reading of the output in decibels below a one-milliwatt reference level and microvolts or millivolts as marked, with a 50-ohm resistive load. Setting the one-milliwatt reference level is a function of the power monitoring circuit.

3-5. MODULATED OPERATION

In modulated operation, the klystron keying voltage may be supplied by an external pulse or by the modulator section, which may be triggered by an internal pulse or sawtooth, or by an external pulse. Delayed and undelayed sync pulses are available when the modulator supplies the keying voltage, but none are available when the keying voltage is supplied by the external source.

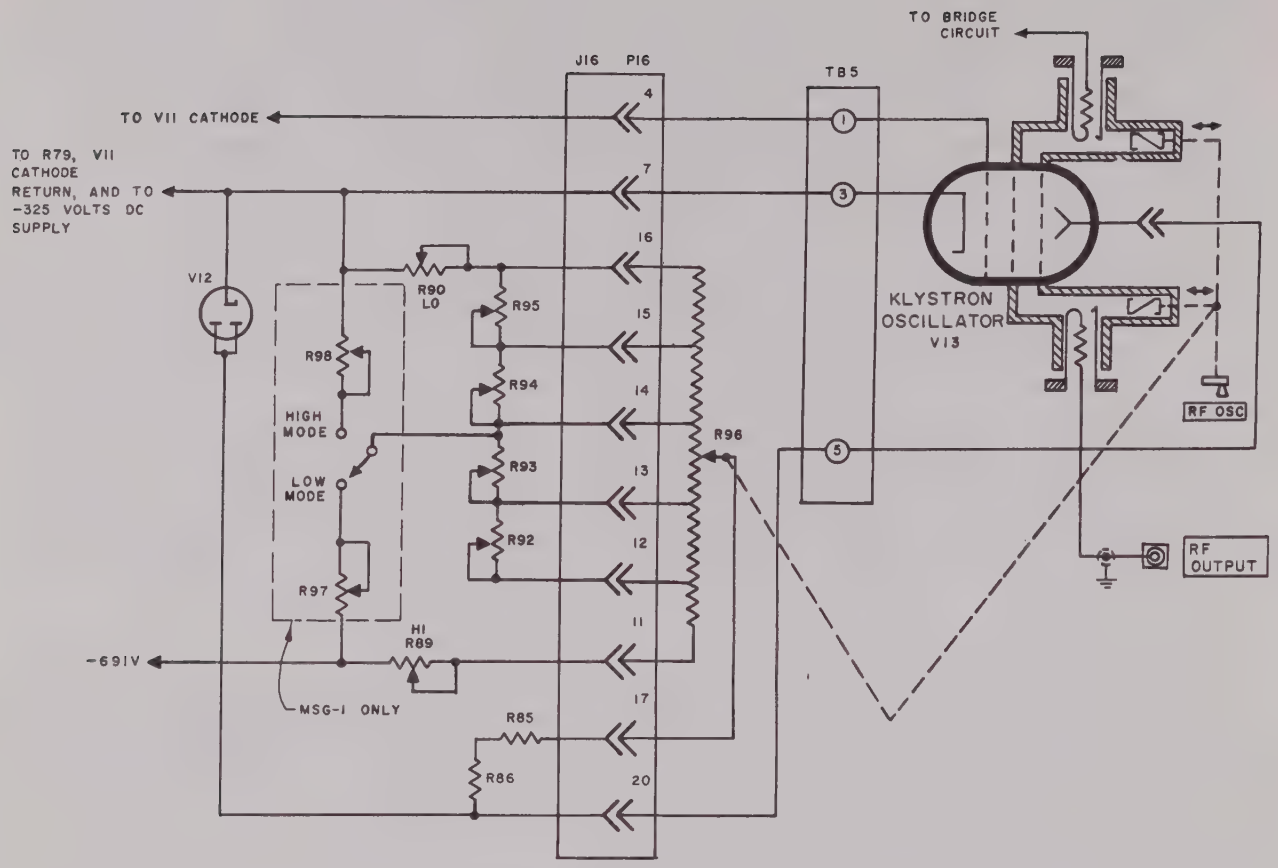


Figure 4. Klystron Oscillator, Simplified Schematic

3-6. INTERNAL MODULATION

The signal generator functions as a self-triggered self-synchronous pulse generator when SYNC SELECTOR S1 and MODULATION SELECTOR S3 are both set to their INT positions. The keying voltage is then supplied by the modulator circuit which is triggered by the rate multivibrator.

3-7. Rate Multivibrator V6. A 12AT7 tube, functioning as a free-running multivibrator, supplies a triggering square wave of a controlled repetition rate. The repetition rate is determined by the settings of certain associated front panel and chassis adjustment controls. Its period is determined by the value of the capacitance (either C20 and C23 or C21 and C24) switched into the plate-to-grid circuit of tubes V6A and V6B by means of sections B and C of RATE MULTIPLIER selector S2, and by the value of resistance set by sections B and C of PULSE RATE control R41 in series with chassis 4,000 PPS ADJUST controls R48 and R49, in the plate circuits of tubes V6A and V6B. With RATE MULTIPLIER S2 rotated to its X1 position (C21 and C24 in the circuit), the pulse rate is adjustable from 40 to 400 pps by the setting of potentiometer R41. With RATE MULTIPLIER S2 in its X10 position (C20 and C23 in the circuit), the pulse rate is adjustable from 400 to 4,000 pps by means of the same control, R41. The 40 PPS ADJ control R43 and the 4,000 PPS ADJ controls R48 and R49 are provided as calibration controls which enable both the low and high pulse repetition frequency limits to be set accurately during servicing checks. A square wave is produced at the plate of V6B and is applied to the grid of voltage discriminator stage V2A.

3-8. Voltage Discriminator V1B and V2A. The voltage discriminator uses one section each of two dual-triode 12AT7 type tubes to provide constant-amplitude triggering pulses. During internal modulation, the discriminator is triggered and its pulse rate controlled by the V6 output pulse. The positive pulses developed at the output of the voltage discriminator are applied to the differentiating network C4 and R13. The resulting sharp positive pulses are coupled to the grid of trigger amplifier V2B and through crystal rectifier CR5 to the undelayed sync blocking oscillator, V7. They are also applied to the input of the klystron keying circuit when S7 is in SQ. WAVE position. The negative polarity overshoot is suppressed by crystal rectifier CR1.

3-9. Undelayed Sync Blocking Oscillator. Undelayed sync blocking oscillator V7 uses a shock-excited blocking oscillator circuit to provide sharp, narrow-peak undelayed triggering pulses. The undelayed pulse coincides in time with the leading edge of the modulated rf test signal. Pulses of approximately one-microsecond duration, with a minimum amplitude of 25 volts positive and with a repetition rate identical to that of the rate multivibrator are available at the UNDELAYED SYNC output jack on the front panel.

3-10. Trigger Amplifier V2B and Delay Multivibrator V3. The sharp positive pulse which results from differentiating the output of the voltage discriminator is fed to the grid of trigger amplifier V2B. The amplified negative pulse output of V2B is coupled to the grid of V3B, the normally-on section of the delay multivibrator. A negative pulse is developed in the cathode circuit and is fed to V3A which starts to conduct. ADJUST DELAY chassis control R25 sets the level of conduction, and therefore the pulse width or delay, which may be varied by front panel PULSE DELAY control R17. The positive output pulse is taken from the plate of V3B and coupled via C8 to activate delayed sync blocking oscillator V4A.

3-11. Delayed Sync Blocking Oscillator V4A. A monostable blocking oscillator circuit is used to provide triggering pulses with a repetition rate identical to the input trigger pulse and with a time delay dependent upon the width of the input pulse. Positive pulses developed at the cathode of V4A are available at the DELAYED SYNC front panel jack and may be utilized as delayed sync trigger pulses. Negative pulses developed at the plate of V4A are coupled to delayed trigger blocking oscillator circuit V4B.

3-12. Delayed Trigger Blocking Oscillator V4B. A monostable blocking oscillator circuit is used by the delayed trigger blocking oscillator to provide trigger pulses for width multivibrator V8, V9.

3-13. Width Multivibrator V8 and V9. The width multivibrator uses two 6AK6 type pentodes in a monostable multivibrator circuit. Oscillation frequency is controlled by the repetition rate of the driving pulses from the delayed trigger blocking oscillator. The width of the multivibrator pulse is adjustable between 0.5 and 10 microseconds by the PULSE WIDTH control on the front panel. ADJUST WIDTH R58 sets the maximum pulse width. The output is a negative pulse which is taken from the plate of V9 and used to key the klystron oscillator via the pulse amplifier and keyer circuits in pulse-modulated operation. In fm modulated operation, the output of V8 is used to trigger the sawtooth generator.

3-14. Pulse Amplifier V10 and Keyer V11 Circuits. Both the pulse amplifier and the keyer are transitional stages between the klystron and the stages supplying the keying voltage. With no signal applied to its input, V10 conducts. As plate current is drawn, the potential at the grid of keyer V11 is lowered. This action reduces the plate current of V11 and lowers the potential drop across its cathode resistor R82. In this manner the voltage at the klystron control grid, which is connected to the V11 cathode, is brought down to cut-off and klystron oscillations cease. Upon application of the negative pulse from V9, V10 is cut off for the duration of the pulse. During this cut-off period, the klystron cathode-to-grid voltage is determined by the setting of the BEAM CURRENT ADJ. R84, and the klystron circuit oscillates. Therefore the power output and frequency for the pulse duration is the same as that for cw operation, except that a pulse-modulated microwave output is produced. The pulse has the same width and occurs at approximately the same instant as the applied modulating pulse.

3-15. EXTERNAL SYNC MODULATION

Operation of the generator with external sync modulation is identical with internal modulation operation except that SYNC SELECTOR S1 is in SIN, - or + position, V10 is inoperative, and the voltage discriminator is triggered by an external pulse which is applied at SYNC IN jack J4 on the front panel and amplified by SYNC amplifier V5A. The SYNC SELECTOR position is set to correspond with the type and polarity of the applied external signal.

3-16. EXTERNAL PULSE MODULATION

MODULATION SELECTOR S3 is set to either EXT NEG or EXT POS position, depending upon the polarity of the externally applied signal. In EXT NEG position the external signal is applied to V8 which inverts its polarity and feeds the resultant positive pulse to V9. In EXT POS the positive pulse is fed directly to V9. After amplification and polarity inversion by V9, the resultant negative pulse is fed to the control grid of pulse amplifier V10. The action of V10 and V11 in keying the klystron is described in paragraph 3-14.

3-17. FM MODULATION

When MODULATION SELECTOR S3 is in FM position, a sawtooth voltage from the sawtooth generator and amplifier V5 is fed to capacitor C45. This capacitor feeds the voltage directly to the repeller electrode of the klystron oscillator tube. The output of the oscillator is then frequency-modulated at a deviation dependent on the setting of FM AMPLITUDE control R36.

3-18. POWER SUPPLIES

NOTE

Wiring to TB6 is adjustable to enable the equipment to be operated on different input voltage systems.

Two separate electronically regulated power supplies are incorporated in the signal generator. The beam reflector and keyer supply provides negative voltages to the plates and cathodes of V10 and V11; to the grid, cathode and repeller of klystron V13; to the control grids of V4 and V7; and to the +250 volt supply for a reference voltage. The 250 volt supply provides positive voltages to the modulator circuit, tubes V1 through V9 and to the power monitor bridge circuit.

3-19. BEAM REFLECTOR AND KEYER SUPPLY

The beam reflector and keyer supply consists of a full wave rectifier V14, a pi-type filter, and a voltage regulating circuit comprising tubes V15 through V22, and V24. Potentiometer R111 is used to set the minus 691 volt output which supplies the klystron repeller potential. A minus 325 volt potential is provided to the klystron cathode by a connection to the junction of V17 and V18. V22 serves as a cathode-follower to provide a minus 433 volt potential which supplies the required voltages to the klystron grid and to the cathodes of V10 and V11. V21 serves as a cathode-follower to provide a minus 175 volt potential which is used to supply the required voltages to the plates of V10 and V11. A minus 87 volt potential is obtained from the minus 175 volt supply, through resistor R122. V24 serves as the minus 87 volt reference tube.

3-20. +250-VOLT SUPPLY

The 250-volt supply consists of full wave rectifier V34, a pi-type filter and a voltage regulating circuit comprising tubes V35 through V37. The regulator produces an output which is independent of fluctuations in the a-c supply and of changes in load over a wide range. Potentiometer R102 is used to set the 250 volt output of the supply. A 175 volt positive potential is provided by a connection to the junction of R188 and R189. A 108 volt positive potential is obtained across voltage regulator V36.

3-21. PROTECTIVE RELAYS

When switch S5 is closed, ac is applied to all circuits except the beam, keyer and reflector power supply. In order to protect the klystron tube, thermal time delay relay K1 is energized through the normally closed circuit (primary) contacts of hold relay, K2. After a delay of 75 seconds, contacts 3 and 8 of relay K1 close. Thus dc from the bridge circuit supply passes through the coil of hold relay K2, and the normally open circuit (secondary) contacts close and apply ac to the beam keyer and reflector power supply. By means of the flip-flop action of the hold relay contacts and circuit wiring, delay relay K1 is de-energized while the hold relay coil remains energized until power is turned off.

3-22. BRIDGE CIRCUIT.

The bridge circuit consists of a Wheatstone type bridge that measures power by the use of a variable negative-temperature coefficient resistor element, RT1 (thermistor) in the bridge circuit. Changes of thermistor temperature and hence resistance are governed by three factors, (1) by thermal changes in its environment, (2) by the current flowing through it, and (3) by absorbed rf power. By controlling current and ambient temperature, the bridge will determine the rf power by measuring the change in thermistor resistance caused by the applied rf power. Thermistor RT2 is used to correct for any dc unbalance due to ambient temperature changes. Thermistor RT3 is used to compensate for the variation in meter sensitivity due to ambient temperature changes.

3-23. FUNCTIONAL OPERATION OF THE MECHANICAL COMPONENTS

The principal mechanical components are the oscillator gear box assembly and the thermistor and attenuator drive assembly. The function of the oscillator gear box is to provide for single control by the RF OSC knob of the choke plunger (operating frequency), of the frequency dial, and of the tracking potentiometer (repeller voltage). The function of the thermistor and attenuator drive assembly is to move the thermistor probe (power monitor) and the attenuator probe (power output) inside their respective waveguides. Both assemblies are mounted on a common casting. Movement of the thermistor drive assembly is controlled by the POWER SET knob while movement of the attenuator drive assembly is controlled by the ATTENUATOR knob.

SECTION 4

MAINTENANCE

WARNING

Operation of this equipment involves voltages which are dangerous to human life. Remove power and ground circuits before touching them.

4-1. GENERAL

While extraordinary care is taken in the manufacture and testing of the Polarad Microwave Signal Generators, and each unit is laboratory tested under strict engineering supervision, it is possible that in the course of use the unit may require checking and servicing. The mechanical drive systems are designed to last far beyond the life of the electrical part of the instrument and should not be tampered with unless a mechanical breakdown occurs. The discussion of principles of operation in Section 3, tube socket layout (figure 9), schematics (figures 10 and 11) and table 3 will prove helpful in locating a defect.

4-2. ACCESS TO THE EQUIPMENT

To separate the signal generator from its case, set the unit face down. Release the four camlock fasteners located at each corner at the rear of the dust cover case. Slide the case upwards. To gain access to components located on the rear of the front panel subassembly, proceed as follows:

a. Remove the line cord and rotate the RF OSC knob until the frequency dial is at the high frequency limit. Remove the ten binding head screws which secure the subpanel to the main panel.

b. Pull the front panel subassembly partially out of the main panel. Gently slide the subassembly to the left, over the main panel. Pull out the right hand side of the subassembly and remove the subassembly by sliding it to the right as it is withdrawn from the main panel. Remove connector P16 from its socket to completely disengage the subpanel.

TABLE 3. TROUBLE SHOOTING

Symptom	Probable Defect
Instrument dead and low voltages.	Blown line fuses. Improper input voltage connections on TB6. Poor connection to a-c power source.
Equipment will not synchronize with an external sync signal applied to SYNC IN jack.	SYNC SELECTOR not in proper setting. Defective V2.
No UNDELAYED SYNC pulse; DELAYED SYNC pulse and RF OUTPUT pulse satisfactory.	Defective V7.
No DELAYED SYNC or RF OUTPUT pulse; UNDELAYED SYNC pulse satisfactory.	Defective V4; Defective V3; Defective V4, V8, or V9.
Unstable UNDELAYED SYNC, DELAYED SYNC, and RF OUTPUT pulses.	Defective +250-volt supply (V34 through V37).
Irregular RF OUTPUT pulse, or pulse dies out over part of the tuning range.	Incorrect voltage applied to repeller of klystron V13.
Low or no rf output; little or no reading on POWER SET meter; pulse output satisfactory.	Improper or no beam voltage applied to V13. Incorrect setting or drift of beam current. Defective klystron V13.
Erratic RF OUTPUT pulse; video pulse satisfactory, and RF OUTPUT satisfactory in CW position of MODULATION SELECTOR.	Incorrect voltage applied to repeller of V13. Defective klystron V13.
No RF pulse output; CW output, DELAYED SYNC and UNDELAYED SYNC pulses satisfactory.	Defective V4, V8, V9, and/or V10, V11.
CW and pulsed RF OUTPUT satisfactory, but no output in FM position of MODULATION SELECTOR.	Defective V5 and/or V9. Defective CR4.
UNDELAYED SYNC satisfactory, but multiple RF pulsed output is obtained.	Defective CR3.
UNDELAYED SYNC satisfactory, but multiple DELAYED SYNC output pulses are obtained.	Defective CR2.
CW RF OUTPUT satisfactory, but no RF OUTPUT when external modulation signal is applied to EXT MOD jack J10.	Defective V8, V9, and/or V10, V11.
RF OUTPUT pulse and/or DELAYED SYNC output does not occur on every cycle, but skips second or third cycle.	PULSE DELAY control improperly set for given pulse repetition frequency. Incorrect V4A and/or V4B bias.
Unstable regulation of d-c power supply voltages with slight variation in power line voltage, or with change in circuit operation.	Defective V14 through V23. Improper setting of chassis voltage adjustments. Power source not within rated frequency.

4-3. REPLACEMENT OF KLYSTRON OSCILLATOR TUBE

a. Remove the front panel subassembly as directed in paragraph 4-2, above.
b. Free the tube cover clamp and slide back the tube cover.
c. Remove the socket from the tube.
d. Loosen the klystron retainer nut with a spanner wrench.

NOTE

Do NOT remove the retainer nut completely. A counterclockwise turn is sufficient to release the locking action.

e. Grasp the projecting end of the klystron tube, gently rotating it in a clockwise direction, while simultaneously withdrawing the tube.

f. Carefully insert a replacement tube into the cavity. Gently push the new tube into the center of the cavity and press all the way in against a noticeable resistance. Continue pushing the tube into the cavity, giving the tube a slight clockwise twist until it meets a positive stop. Tighten the klystron retainer nut and replace the tube socket and cover.

g. After replacing the klystron, rotate BEAM CURRENT ADJ R84 completely counterclockwise.

h. Due to variations in klystron tube characteristics, replacement of the klystron will require resetting of the beam current, checking of the repeller voltage tracking and checking of the dial calibration.

4-4. ROUTINE MAINTENANCE

Air filter cleaning and re-oiling are required whenever the air filter appears dirty or clogged on visual inspection. Remove the four screws, keeping the filter holder on the case, and remove the filter holder. Then remove the four self-tapping screws keeping the filter in the holder. Clean the filter with carbontetrachloride. Dip into a mixture of 1 part SAE No. 30 oil and 3 parts of thinner. Shake out and wipe fan blades. Replace the filter.

SECTION 5

ADJUSTMENT AND ALIGNMENT

WARNING

Operation of this equipment involves voltages which are dangerous to human life. Remove power and ground circuits before touching them.

5-1. GENERAL

The Polarad Microwave Signal Generator is a calibrated measuring instrument. Unnecessary adjustments of the klystron oscillator and calibrated modulator circuits should not be made, since these changes may result in a loss of accuracy. Proper test equipment, such as that listed in paragraph 5-4, is required for tracking and calibration procedures. The general procedure is outlined briefly below:

a. Check the power supply voltages; set the beam current.
b. Track the repeller voltages for cw operation.
c. Track the repeller voltages for pulse operation.
d. Calibrate the frequency dial.

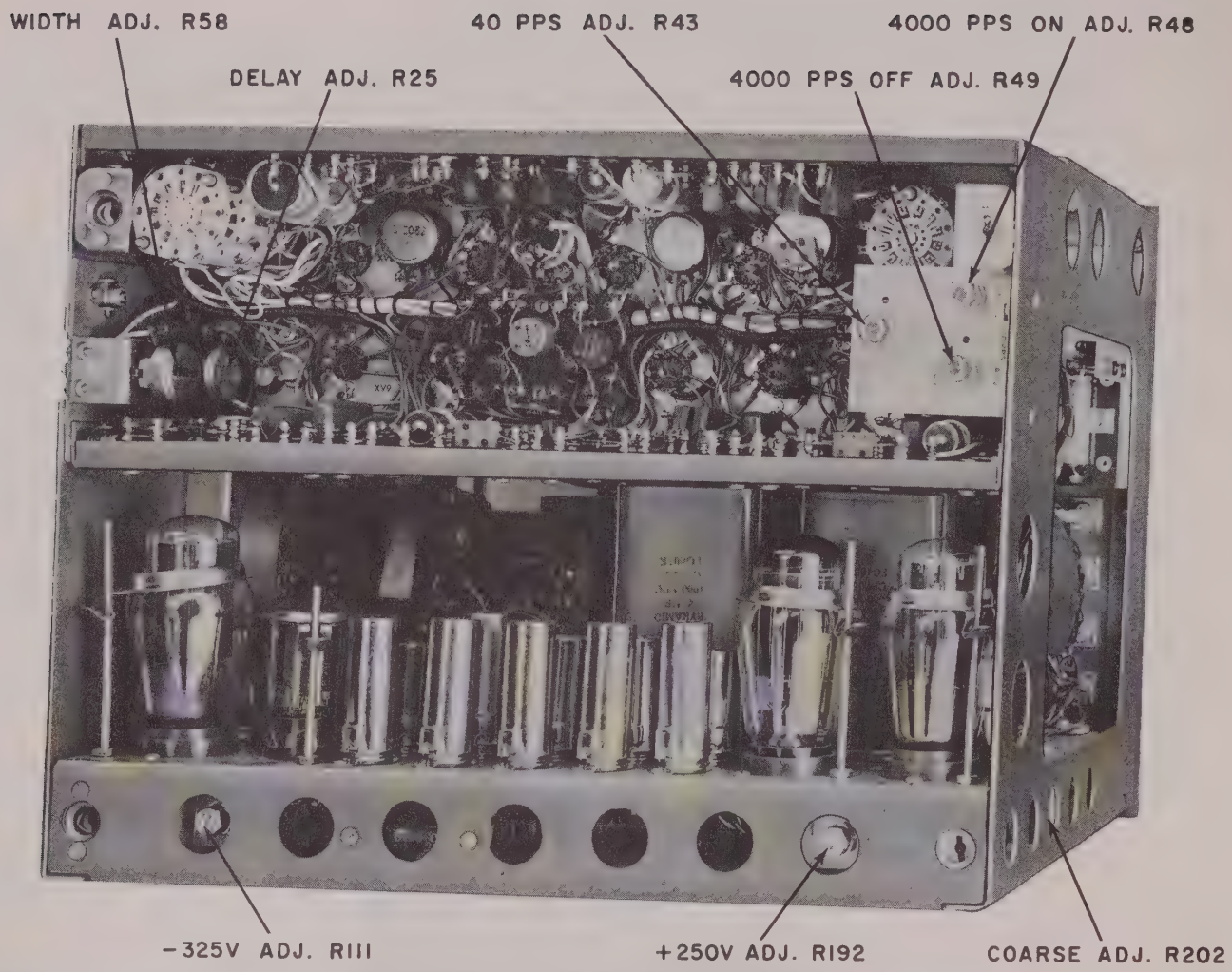


Figure 5. Rear Oblique View of Signal Generator

NOTE

All potentiometers located on the instrument chassis are provided with shaft locks. Loosen the locknuts to permit adjustments. After adjustments, retighten the locknut. Use an open-end wrench to prevent the shaft from rotating as the wrench is turned.

5-2. POWER SUPPLY ADJUSTMENTS

The procedure for checking and adjusting the outputs of the +250 volt supply and the beam and keyer supply is as follows:

a. +250 volt supply. Connect a voltmeter from chassis ground to the junction of C83 and R190, R194, and R195. (These components are located on a terminal board on the bottom of the equipment. The board is marked for identification of the components.) The voltmeter reading should be +250 volts. If necessary, vary R192 located at the rear of the chassis (figure 5) until a reading of +250 volts is obtained.

b. Beam reflector and keyer supply. Connect a voltmeter from chassis ground to resistor R108 at the end of the resistor not connected to R106 and R107. (The resistors are located on terminal board TB2 on the bottom of the equipment.) The voltmeter should read 325 volts. If necessary, vary R111 located at the rear of the chassis (figure 5) until a reading of 325 volts is obtained.

5-3. BEAM CURRENT ADJUSTMENT

To adjust the beam current proceed as follows:

a. Remove the signal generator from its case.
b. Set the leads of a voltmeter to test points TP1(+) and TP3(-).
c. Turn POWER switch to ON and allow one minute for the time delay.
d. With MODULATION SELECTOR S3 at its CW position, rotate BEAM CURRENT ADJ. R84 (figure 6) until the voltmeter reads +10 volts. (Approximately -10 volts should be obtained upon switching to the ZERO SET position.)
e. Place leads of voltmeter across R115 (56 ohms), located at underside of power supply chassis. Voltmeter should read approximately +1.5 volts.
f. Turn POWER switch to OFF and remove the voltmeter leads.

5-4. REPELLER VOLTAGE TRACKING PROCEDURE

The repeller voltage tracking procedure which follows assumes that the unit was previously aligned and operating but that the klystron was changed. The repeller voltages are first adjusted for proper mode trace on the oscilloscope in cw operation and then in pulse-modulated output. The following equipment is required:

a. Two waveguide-to-coaxial adapters for coupling the RF OUTPUT connector to the input of a precision frequency meter.
b. One coaxial-to-waveguide adapter and crystal mount with dc return, PRD type 612A or equivalent.
c. One 1N23B crystal diode.
d. One reaction type frequency meter having an accuracy of 0.1% or better, such as the Polarad Frequency Meter, Model FL, or equivalent, covering the frequency range 950 mc to 2,000 mc (for MSG-1).
e. One reaction type frequency meter having an accuracy of 0.1% or better, such as the Polarad Frequency Meter, Model FS, or equivalent, covering the frequency range 2,000 to 4,000 mc (for MSG-1 and MSG-2A).
f. One reaction type frequency meter having an accuracy of 0.1% or better, such as PRD Type 574, or equivalent, covering the frequency range 3,950 to 5,850 mc (for MSG-2A).
g. One dc voltmeter (20,000 ohms-per-volt).

5-5. TEST SETUP.

The test setup described below permits the display of the klystron oscillator repeller modes on the oscilloscope screen, while using the internal sawtooth sweep from the equipment as the horizontal time base line. A typical repeller mode trace is shown in figure 7. To obtain the mode trace on the oscilloscope, set up the equipment as described below and proceed as directed in paragraphs 5-6 to 5-8 which follow.

a. Remove the signal generator from its dust cover case and arrange the test setup as shown in figure 8.
b. Connect a test lead to the reflector connection at test point TP2, located at side of keyer chassis (figure 6).
c. Connect the opposite end of the test lead, via a one-microfarad dc blocking capacitor rated at 1,000 VDCW or greater, to the horizontal plate input of the oscilloscope.
d. Be sure to connect a common ground lead between the signal generator and the oscilloscope.

5-6. PRELIMINARY STEPS

a. With MODULATION SELECTOR S3 at its CW position, apply operating power to the signal generator, and allow at least a 20-minute warmup period.
b. Rotate the SYNC SELECTOR S1 to its INT position.
c. Set RATE MULTIPLIER selector S2 and PULSE RATE control R41 to produce any desired sweep rate within the range from 40 to 4,000 sweeps per second.
d. Rotate MODULATION SELECTOR S3 to its FM position to obtain frequency-modulated rf output test signals.
e. Adjust the POWER SET control to maintain meter indicator on scale.

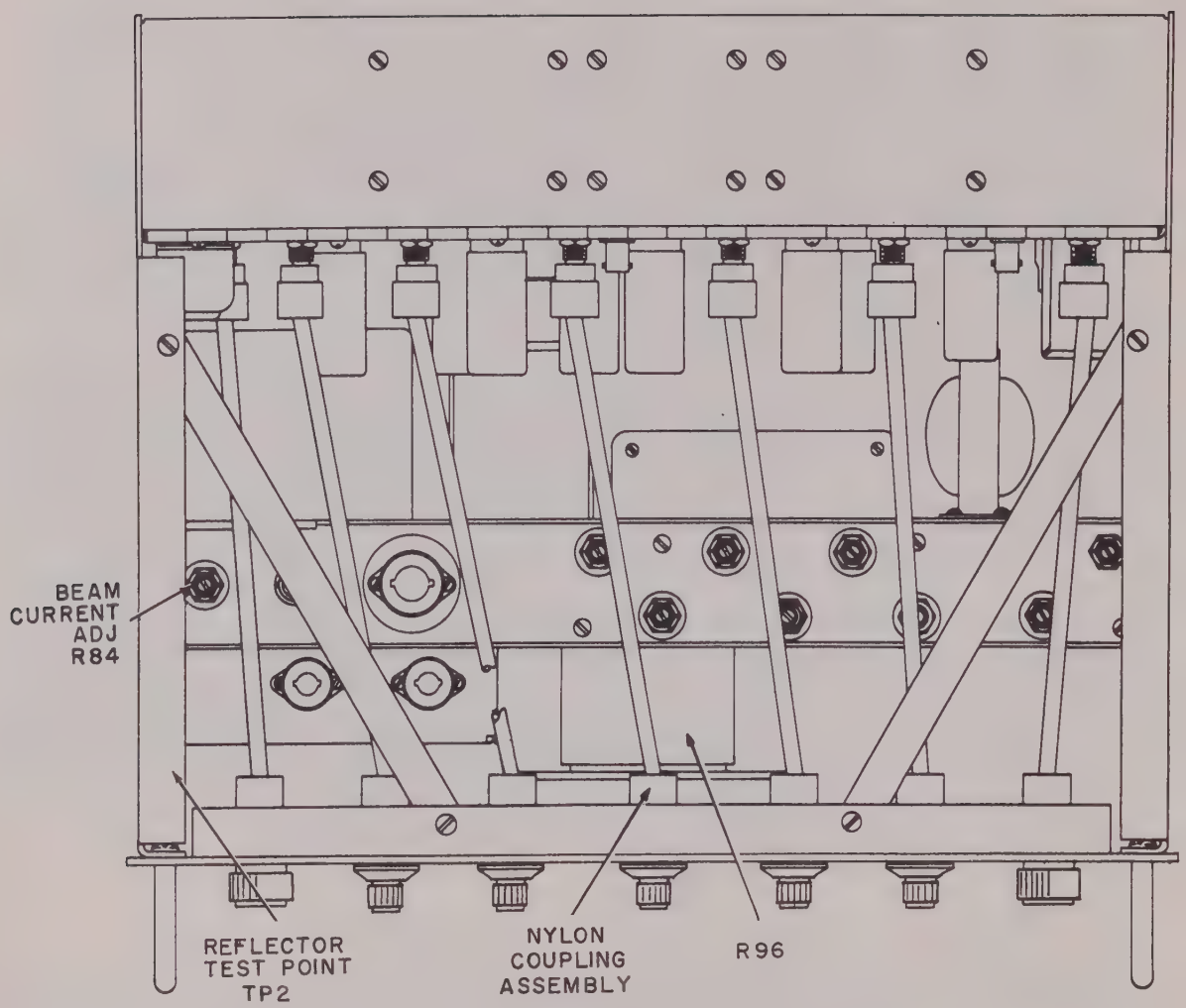


Figure 6. Top View of Signal Generator

5-7. TRACK POTENTIOMETER ADJUSTMENTS (CW OPERATION)

a. After the test equipment has been set up and the controls set as directed above, connect the negative lead of a 20,000-ohm-per-volt meter to reflector connection TP2, and the positive lead to the terminal of resistor R108 not connected to R106. (The desired terminal is at the edge of terminal board TB2 which is located on the bottom of the chassis.) Then proceed as follows:

Equipment	Step	Set Frequency Dial To:	Indication		If indication is not correct rotate:
			Voltage*	Mode	
MSG-1	1	2400 mc	280 V	At center	Potentiometer R89, HI
	2	950 mc	85 V	of trace	Potentiometer R90, LO
MSG-2A	1	4600 mc	320-340 V	At center	Potentiometer R89, HI
	2	2000 mc	35 V	of trace	Potentiometer R90, LO

*approximate. There may be a variation of ±10% due to differences in klystron tubes.

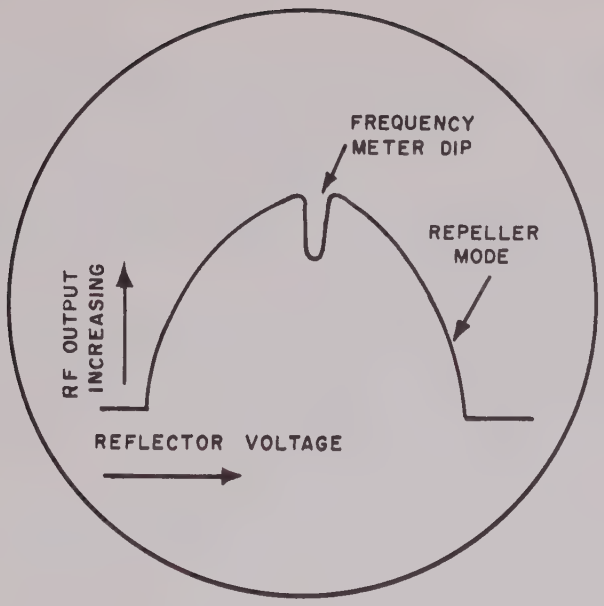


Figure 7. Typical Mode Trace

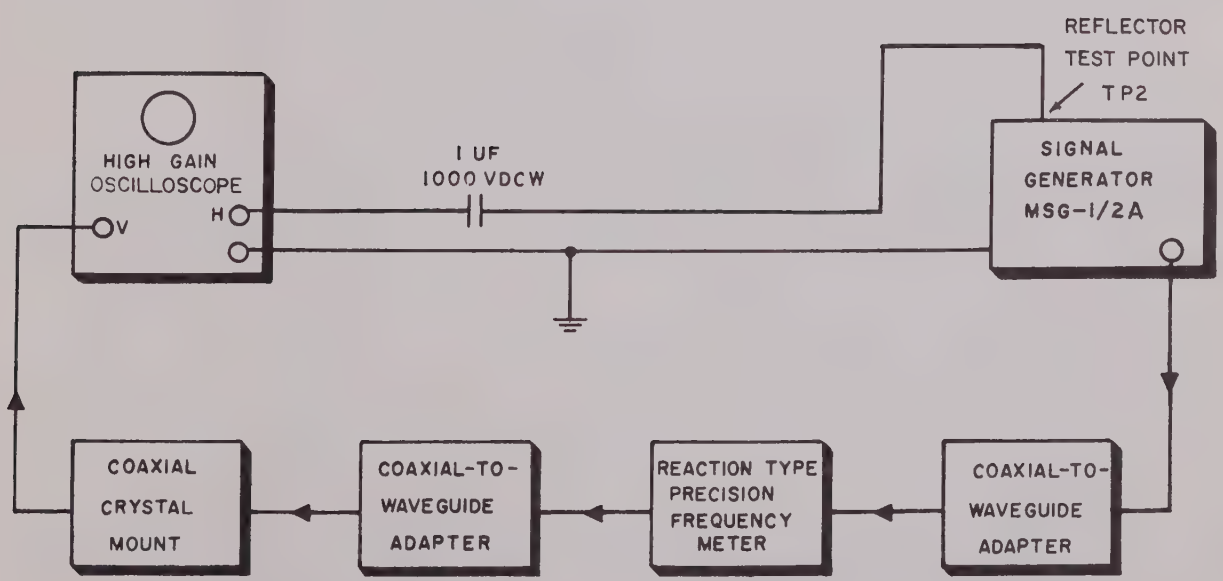


Figure 8. Test Set-up Diagram

b. Recheck the repeller voltages at the high and low dial frequencies by repeating steps 1 and 2 above.

NOTE

If the klystron has been replaced, the above procedure should afford correct repeller tracking. Failure to track properly may indicate a defective replacement klystron.

c. Check the intermediate tracking points by proceeding as directed below.

Step	Set Frequency Dial To:	Indication		If indication is not correct rotate:
		Voltage*	Mode	
		MSG-1		
3	1800 mc.	165 V	At	Track 4, R92
4	1500 mc.	115 V		Track 3, R93
5	Rotate dial towards the low end until a click is heard at about 1250 mc. Rotate the dial backward and lock the dial as the second click is heard.	55 V	center	HIGH MODE Potentiometer, R98
6	Release the dial lock and rotate the dial toward the low end. Lock the dial as the click is heard.	175 V	of	LOW MODE Potentiometer, R97
7	1100 mc.	115 V	trace	Track 1, R95

*approximate. There may be a variation of ±10% due to differences in klystron tubes.

NOTE

Track 2, R94, is not readjusted unless LOW MODE potentiometer R97 cannot obtain the required indications.

Step	Set Frequency Dial To:	Indication		If indication is not correct rotate:
		Voltage*	Mode	
		MSG-2A		
3	2300 mc.	60 V	At	R95
4	2650 mc.	80 V	center	R94
5	3100 mc.	135 V	of	R93
6	3800 mc.	220 V	trace	R92

*approximate. There may be a variation of ±10% due to differences in klystron tubes.

d. The repeller voltages must now be rechecked, as directed above, because of the interacting effects of the adjustments. Minor adjustments are to be made, as necessary, to complete the alignment procedure, with the signal generator producing continuous-wave output signals.

5-8. TRACK POTENTIOMETER ADJUSTMENTS (PULSE-MODULATED OUTPUT)

The repeller voltage tracking must now be rechecked throughout the tuning range. Proceed as follows:

a. Rotate MODULATION SELECTOR S3 to its INT position.
b. Set SYNC SELECTOR S1 to its INT position.
c. Set RATE MULTIPLIER S2 and PULSE RATE control R41 to produce a pulse repetition frequency of approximately 1,000 pps.
d. Perform the complete test outlined in paragraph 5-7 above, with the signal generator this time producing a pulse-modulated output. Readjust any of the TRACK controls, if necessary, in order to obtain the best possible tracking in cw and pulse-modulated outputs through the entire frequency range.

5-9. TRACKING ADJUSTMENT AFTER REPLACEMENT OF A TRACK POTENTIOMETER

After replacement of one of the track potentiometers, R89, R90, R92 to R95, set the arm of the new potentiometer to the center of its travel and proceed as directed in paragraph 5-7.

NOTE

If trouble is experienced in the alignment of the repeller tracking circuit, it may be localized to an incorrect repeller voltage supply by measuring the voltage across the bank of tubes V18 through V20. The voltage should be 366 volts dc for Model MSG-1 and 408 volts dc for Model MSG-2A.

WARNING

Be sure that operating power is disconnected in making the above test prod connections. The dc voltage at V20 is 691 volts negative for Model MSG-1 and 733 volts dc negative for Model MSG-2A. The voltage at V18 is 325 volts negative, with respect to chassis, for both models.

5-10. FREQUENCY DIAL CALIBRATION

a. Connect the test setup and equipment as described in paragraphs 5-5 and 5-6, using the proper reaction type frequency meter to check the low-end frequency.* Set the signal generator frequency dial to the low-end frequency* and tune the frequency meter for a dip (or wiggle) at the center of the mode trace. Note the frequency meter setting.
b. Remove the frequency meter and substitute another to measure the high-end frequency.** Set the signal generator to the high-end frequency** and tune the frequency meter for a dip (or wiggle) at the center of the mode trace. Note the frequency meter setting.
c. Check the frequency meter settings noted in a and b above. They should be ±1% of the end frequencies. No frequency correction is necessary if the generator output signals fall within these limits. If frequency correction is necessary, reset the frequency dial as described below to bring the high and low frequency ends within 1% of their readings.

5-11. DIAL FREQUENCY CORRECTION

If the frequency dial reading differs from the actual frequency output by more than 1%, proceed as follows:
a. Remove the dial light and draw a line on the dial light socket directly up from the hairline.
b. Remove the dial cover.
c. Set the MODULATION SELECTOR to CW position. Turn power to ON and allow twenty minutes for the signal generator to warm up.

CAUTION

Adjust POWER SET control to prevent the meter needle from going off scale.

*Low-end frequency:
MSG-1 -- 950 mc
MSG-2A -- 2000 mc

**High-end frequency:
MSG-1 -- 2400 mc
MSG-2A -- 4600 mc

d. Set the frequency meter to the high-end frequency** and tune the signal generator until the dip (or wiggle) appears at the center of the mode trace. Lock the dial with the dial lock.

e. Loosen the three screws holding the frequency dial to the hub. Using the pencil line as a hairline, reset the frequency dial to correct the frequency error and tighten the three screws.

f. Recheck the dial calibration.

g. Replace the dial cover and dial light and recheck the dial calibration.

5-12. MODULATOR ELECTRICAL ADJUSTMENTS

Seven internal calibrating potentiometers are provided on the modulator chassis. These are shown in figure 5 as:

a. 40 PPS ADJ control R43, accessible from the rear of the chassis.

b. 4000 PPS and SYMMETRY ADJ controls R48 and R49, accessible from the rear of the chassis.

c. ADJUST DELAY control R25, accessible from the right side of the chassis.

d. ADJUST WIDTH control R58, accessible from the right side of the chassis, adjacent to R25.

5-13. PULSE RATE RECALIBRATION

Recalibration of PULSE RATE control is required whenever the pulse repetition frequency of the signal generator is incorrect, as compared to a standard signal source. In addition, recalibration is required after replacement of rate multivibrator V6, PULSE RATE control R41, 40 PPS ADJ control R43, and/or 4000 PPS ADJ controls R48 and R49. To calibrate the PULSE RATE control, perform the steps outlined below for the 40 pps and 4,000 pps adjustments.

5-14. 40 PPS ADJ CONTROL ADJUSTMENT

Use an accurately calibrated audio oscillator, capable of producing a 3-volt rms signal at a frequency of 40 cps, and a Dumont Model 294A Oscilloscope, or equal.

a. Set the SYNC SELECTOR S1 to its INT position.

b. Set RATE MULTIPLIER selector S2 to its X1 position.

c. Set PULSE RATE control R41 to 40.

d. Set PULSE DELAY control R17 to approximately 150.

e. Set PULSE WIDTH control R65 to its approximate mid-way position.

f. Set MODULATION SELECTOR S3 to its INT position.

g. Connect the vertical input lead from the oscilloscope to pin 1, the output plate of delay multivibrator V3, accessible from the rear of the signal generator.

h. Connect the output of the audio oscillator to the horizontal amplifier on the oscilloscope, with the audio oscillator producing a signal of exactly 40 cps. Also couple the output of the audio oscillator, via a 1,000 micromicrofarad capacitor, to the vertical input on the oscilloscope. An elliptical trace should now appear on the oscilloscope screen. If the trace is not a good ellipse, substitute another coupling capacitor of a different value for the 1,000 uuf capacitor recommended above.

i. The trace on the oscilloscope screen should now be a stationary ellipse, with a rotating pip, resembling the symbol for a musical note. Unlock the shaft of 40 PPS ADJ control R43 and rotate the shaft carefully until the trace remains stationary and a single pip, open at the elliptical baseline, is obtained. (Two pips appearing on the trace indicate that the output of the signal generator is twice the rate of the calibrated audio oscillator.) If the baseline beneath the single pip does not open, the output of the signal generator is at a lower frequency (subharmonic) than the audio oscillator frequency.

j. If the PULSE RATE control itself (triple potentiometer R41) was replaced, loosen the two No. 6-32 multiple spline setscrews located 90° apart on the nylon coupling assembly which couples the PULSE RATE extension shaft to the front panel control. (This coupling assembly is accessible from the top of the signal generator, directly to the rear of the equipment front panel, as shown in figure 6.) Rotate the PULSE RATE extension shaft by hand to produce the trace having a single pip open at the elliptical baseline. Turn the control knob to the "40" position on its calibrated arc. While holding the knob in this position, tighten the two setscrews to the panel assembly shaft.

**High-end frequency: MSG-1 -- 2400 mc; MSG-2A -- 4600 mc.

5-15. 4000 PPS ADJ AND SYMMETRY CONTROL ADJUSTMENT

Use a triggered oscilloscope with a calibrated sweep, such as the Tektronix Model 514. Set the front panel controls as directed in steps a to f of paragraph 5-14, except:

a. Set the RATE MULTIPLIER selector S2 to its X10 position and the PULSE RATE control knob to its 400 position.

b. Then connect the probe of the vertical input of the oscilloscope to pin 1 of V6.

c. Set the sweep of the triggered oscilloscope to 250 microseconds.

d. Adjust R48 and R49 so that the period of each half of the square wave is set to 125 microseconds. Note that R48 affects one half and R49 the other half of the square wave.

e. As a result of this adjustment, it is recommended that the 40 PPS ADJ control setting be rechecked in order to obtain best overall accuracy. After accurately setting controls R43, R48, and R49, be sure to lock their shafts in the desired position by tightening the locknuts.

5-16. PULSE DELAY RECALIBRATION

Recalibration of PULSE DELAY control R17 is required whenever the delay between the UNDELAYED SYNC trigger pulse and the DELAYED SYNC trigger pulse, as observed on an accurately calibrated oscilloscope sweep trace, is faulty. In addition, recalibration is required after replacement of delay multivibrator V3 or PULSE DELAY potentiometer R17. To recalibrate the front panel control, follow the directions given below:

a. Couple the video output from the UNDELAYED SYNC jack of the signal generator to the trigger input for the horizontal sweep on an oscilloscope or synchroscope.

b. Use a calibrated baseline on the synchroscope as the horizontal sweep, of 400 microseconds total width, with calibrated marker pips at each 100 microseconds along the baseline.

d. Couple the video output from the DELAYED SYNC jack of the signal generator to the vertical input of the synchroscope.

d. Set all controls, except PULSE DELAY, on the front panel of the signal generator as directed in paragraph 5-14.

e. Set the PULSE DELAY control to the "300" mark on its calibrated arc.

f. The signal from the DELAYED SYNC jack of the signal generator should appear as a pip at the 300-microsecond marker on the synchroscope time baseline. If the pip is not at the 300-microsecond mark, vary ADJUST DELAY control R25, accessible from the right side of the signal generator chassis, until the pip is on the calibration mark. Be sure to tighten the locknut after satisfactory adjustment has been completed.

g. If the PULSE DELAY control itself (R17) has been replaced, loosen the two No. 6-32 multiple spline setscrews located 90° apart on the nylon coupling assembly which couples the PULSE DELAY extension shaft to the front panel control. (This coupling assembly is directly to the rear of the front panel, as shown in figure 6.) Rotate the PULSE DELAY extension shaft by hand until a pip delayed 300 microseconds from the start of the sweep is obtained on the scope screen. Turn the loose control knob for the PULSE DELAY potentiometer to the "300" mark on the calibrated arc. While holding the knob in this position, tighten the two setscrews on the nylon coupler, thereby securing the coupler to the front panel shaft. Check the overall calibration of the control knob, and make any minor adjustments which may be required, by further fine tuning of the ADJUST DELAY control R25, mounted on the right side of the modulator and main chassis.

5-17. PULSE WIDTH RECALIBRATION

Recalibration of PULSE WIDTH control R65 is required whenever the duration of pulse-modulated signals is faulty, as established by a check with an accurately calibrated oscilloscope mark-sweep baseline or other standard. In addition, recalibration is required after replacement of width multivibrator tubes V8 and V9, and/or replacement of PULSE WIDTH potentiometer R65. To recalibrate the circuit, follow the directions listed below:

a. Couple the video output from the DELAYED SYNC jack J8 of the signal generator to the trigger input for the horizontal sweep on an oscilloscope or synchroscope.

b. Couple the signal from the RF OUTPUT connector J13 on the signal generator via a waveform envelope detector (such as a crystal detector) to the vertical input of the synchroscope.

c. Use a calibrated baseline on the synchroscope as the horizontal sweep, of 15 microseconds total width, with calibrated marker pips at each 1-microsecond distance along the baseline.

d. If the setting of ADJUST WIDTH control R58 has been disturbed, or if this potentiometer has been replaced, rotate the front panel PULSE WIDTH control R65 to the "10" mark on its calibrated arc. The signal should yield a rectangular pulse on the scope screen, at the 10-microsecond calibration mark, as measured at the half-amplitude points. If the pulse is not at this point on the baseline, vary ADJUST WIDTH control R58, accessible from the right side of the signal generator, until the pip is on the calibration mark. Be sure to tighten the locknut after satisfactory adjustment has beem completed.

e. If the PULSE WIDTH control itself (R65) was replaced, loosen the two No. 6-32 multiple spline setscrews located 90° apart on the nylon coupling assembly which couples the PULSE WIDTH extension shaft to the front panel control. (This coupling assembly is directly to the rear of the front panel, at the top of the equipment.) Rotate the PULSE WIDTH extension shaft by hand until a rectangular pulse appears on the scope baseline at the 10-microsecond mark. Then turn the loose control knob for the PULSE WIDTH potentiometer to the "10" mark on the calibrated arc. While holding the knob in this position, tighten the two setscrews on the nylon coupler, thereby securing the coupler to the front panel shaft. Check the overall calibration of the control knob, and make any further minor adjustments which may be required, by further fine tuning of the ADJUST WIDTH oontrol R58, mounted on the right side of the main chassis.

5-18. CONTROL SETTINGS

a. Connect the power input cord of the signal generator to a variable transformer, such as the General Radio Co. type V-20HM Variac, capable of delivering from 100 to 130 and 200 to 230 volts ac to the generator, with the power source delivering either 115 or 230 volts ac line voltage.

b. Display the DELAYED SYNC output of the signal generator equipment on the vertical deflection plates of a synchroscope.

c. Rotate the MODULATION SELECTOR to its INT position.

d. Trigger the synchroscope sweep generator with the DELAYED SYNC output pulse from the signal generator.

e. Rotate the variable transformer control so that 130 volts ac is applied to the POWER INPUT receptacle of the signal generator.

f. Rotate the SYNC SELECTOR control to its SIN, -, or + position. Do not apply a sync signal to the SYNC IN jack.

g. Set the RATE MULTIPLIER control to its X10 position. Rotate the PULSE RATE control completely clockwise to obtain a pulse-repetition rate of 4,000 pps.

h. Rotate the PULSE DELAY control to its minimum (counterclockwise) position.

i. Rotate the PULSE WIDTH control to its maximum (clockwise) position.

5-19. TESTING THE MODULATOR FOR MAXIMUM REPETITION RATE

a. Rotate the arm of the variable transformer to apply a line voltage of 100 volts to the POWER INPUT receptacle.

b. Rotate the SYNC SELECTOR control to its INT position.

c. Be sure that the MODULATION SELECTOR is set to its INT position.

d. Set the RATE MULTIPLIER and PULSE RATE controls to produce a prf of 4,000.

e. Rotate the PULSE DELAY control to its extreme counterclockwise (minimum) position.

f. Rotate the PULSE WIDTH control to its "10" setting.

g. Observe the screen of the synchroscope. Vary the PULSE DELAY control from its minimum to its maximum position. If the scope screen indicates that the signal generator is delivering the proper output pulses, with no missing pulses, the modulator satisfies the maximum prf and low line-voltage test.

5-20. TESTING THE MODULATOR FOR MINIMUM PRF

a. Rotate the arm of the variable transformer to apply a line voltage of 130 volts to the POWER INPUT receptacle.

b. Be sure that the SYNC SELECTOR control is set to its INT position.

c. Check that the MODULATION SELECTOR is rotated to its INT position.

d. Set the RATE MULTIPLIER and PULSE RATE controls to produce a prf of 40.

e. Rotate the PULSE DELAY control to its "300" microsecond setting.

f. Rotate the PULSE WIDTH control to its "10" microsecond setting.

g. Observe the screen of the synchroscope. The scope screen should indicate that the output pulses are in synchronism with the output from the UNDELAYED SYNC output jack, and that there are no extraneous pulses at the beginning of each delay period which cannot be timed by resetting of the PULSE DELAY control.

5-21. CALIBRATING COARSE ADJ R202

a. Allow signal generator to remain off at least one hour.
b. Apply power and set the METER ZERO control fully clockwise.
c. Adjust COARSE ADJ R202 until meter goes beyond full scale deflection.

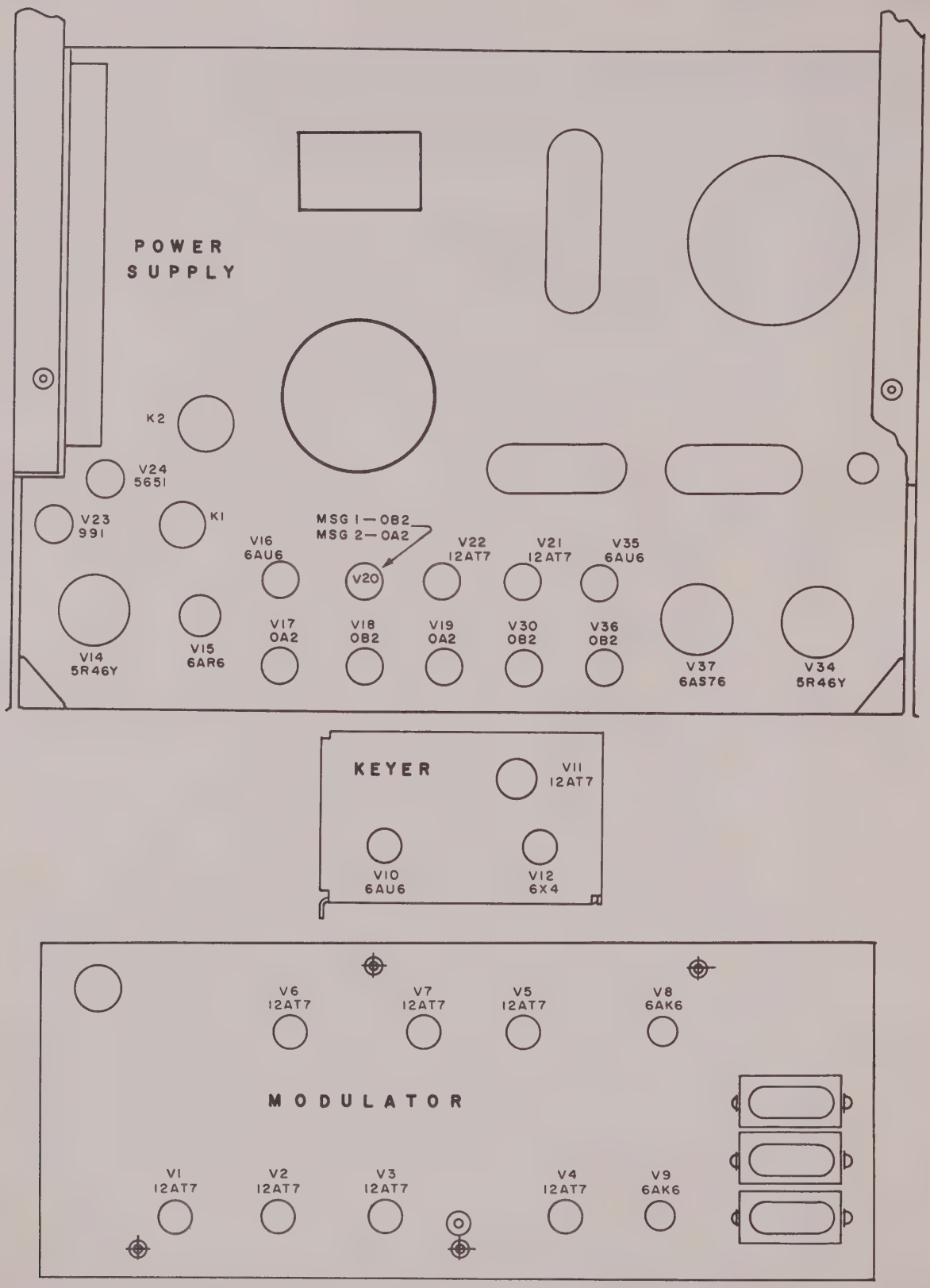
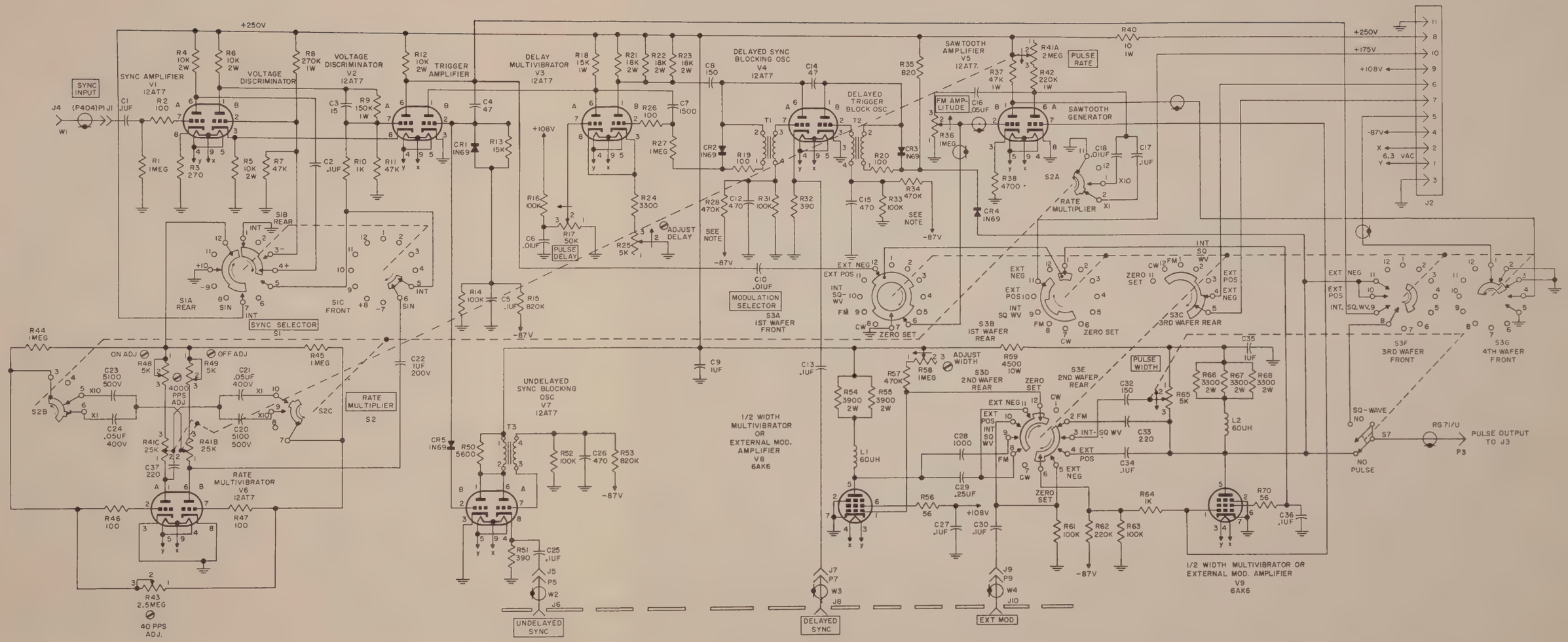
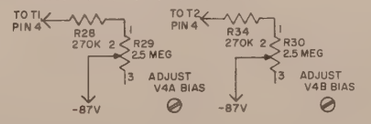


Figure 9. Tube Socket Layout

EP23529A SER. NO. 310 AND UP FOR MSG-1; 321 AND UP FOR MSG-2 A

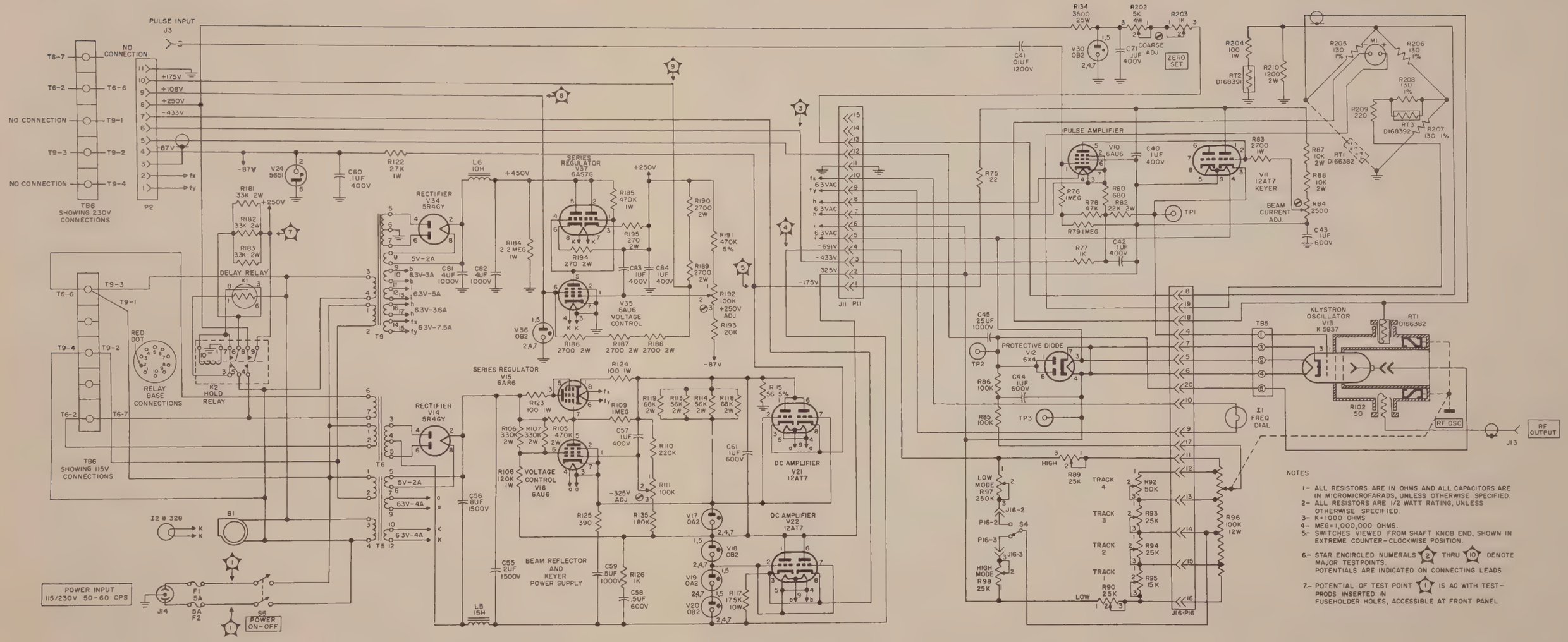


NOTE:
THE CHANGES BELOW ARE FOR THE FOLLOWING EQUIPMENT SERIAL NUMBERS: 146, 150, 155, 156, 159, 161, 167, 168, 170, 171, 172 173, 175, 176, 177, 179, 181, 186, 187, 191, 192



1. UNLESS OTHERWISE SPECIFIED, RESISTORS ARE IN OHMS, 1/2 WATT, ±10%.
2. UNLESS OTHERWISE SPECIFIED, CAPACITORS ARE IN MICROMICROFARADS.

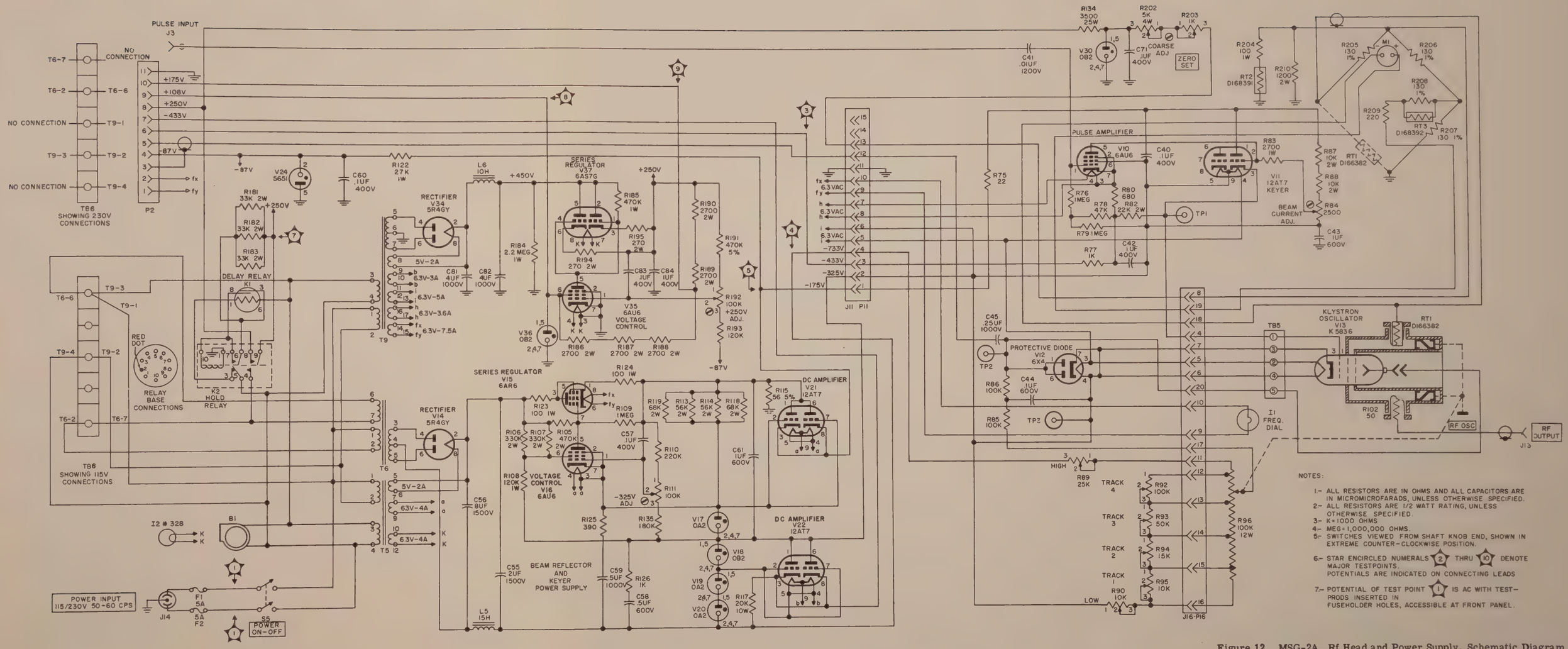
Figure 10. Modulator Section, Schematic Diagram



NOTES

1- ALL RESISTORS ARE IN OHMS AND ALL CAPACITORS ARE IN MICROMICROFARADS, UNLESS OTHERWISE SPECIFIED.
2- ALL RESISTORS ARE 1/2 WATT RATING, UNLESS OTHERWISE SPECIFIED.
3- K=1000 OHMS
4- MEG=1,000,000 OHMS.
5- SWITCHES VIEWED FROM SHAFT KNOB END, SHOWN IN EXTREME COUNTER-CLOCKWISE POSITION.
6- STAR ENCIRCLED NUMERALS (2) THRU (10) DENOTE MAJOR TESTPOINTS. POTENTIALS ARE INDICATED ON CONNECTING LEADS
7- POTENTIAL OF TEST POINT (1) IS AC WITH TEST-PRODS INSERTED IN FUSEHOLDER HOLES, ACCESSIBLE AT FRONT PANEL.

Figure 11. MSG-1, Rf Head and Power Supply, Schematic Diagram



NOTES:

1- ALL RESISTORS ARE IN OHMS AND ALL CAPACITORS ARE IN MICROMICROFARADS, UNLESS OTHERWISE SPECIFIED.
2- ALL RESISTORS ARE 1/2 WATT RATING, UNLESS OTHERWISE SPECIFIED.
3- K=1000 OHMS.
4- MEG=1,000,000 OHMS.
5- SWITCHES VIEWED FROM SHAFT KNOB END, SHOWN IN EXTREME COUNTER-CLOCKWISE POSITION.
6- STAR ENCIRCLED NUMERALS (2) THRU (10) DENOTE MAJOR TESTPOINTS. POTENTIALS ARE INDICATED ON CONNECTING LEADS
7- POTENTIAL OF TEST POINT (1) IS AC WITH TEST-PRODS INSERTED IN FUSEHOLDER HOLES, ACCESSIBLE AT FRONT PANEL.

Figure 12. MSG-2A, Rf Head and Power Supply, Schematic Diagram

SECTION 6
PARTS LIST

6-1. INTRODUCTION

This parts list describes all the electrical parts used in the Model MSG-1 and MSG-2A Signal Generators. The items are listed by schematic reference designation. When a standard part is utilized the number does not appear in the part number column. The part manufactured by the Polarad Electronics Corporation only, will include a part number, and that part may be purchased from Polarad. In general, the same parts are used in both the MSG-1 and the MSG-2A models. When the parts are different, a single asterisk denotes MSG-1 and a double asterisk denotes the MSG-2A. The triple asterisk denotes the changes for the following equipment serial numbers: 146, 150, 155, 156, 159, 161, 167, 178, 170, 171, 172, 173, 175, 176, 177, 179, 181, 186, 187, 191 and 192.

Reference Designation	Description	Polarad Part No.
B1	ASSEMBLY, Blower Motor	C106311
B1A	FAN	BP21839
B1B	MOTOR, Fan	B21838
B1C	FILTER, Air	BP20024
B1D	SPIDER-MOTOR MTG. ASSEMBLY	C106310
C1	CAPACITOR, Fixed, Paper Dielectric; 0.1 uf ±20%, 600 vdc	
C2	CAPACITOR, Fixed, Paper Dielectric; .1 uf ±20%, 400 vdc	
C3	CAPACITOR, Fixed, Mica Dielectric; 15 uuf ±10%, 500 vdc	
C4	CAPACITOR, Fixed, Paper Dielectric; 47 uuf ±10%, 500 vdc	
C5	Same as C2	
C6	CAPACITOR, Fixed, Mica Dielectric; .01 uf ±10%, 300 vdc	
C7	CAPACITOR, Fixed, Mica Dielectric; 1500 uuf ±5%, 500 vdc	
C8	CAPACITOR, Fixed, Mica Dielectric; 150 uuf ±5%, 500 vdc	
C9	CAPACITOR, Fixed, Paper Dielectric; 1 uf ±10%, 400 vdc	
C10	Same as C6	
C11	Not used	
C12	CAPACITOR, Fixed, Mica Dielectric; 470 uuf ±10%, 500 vdc	
C13	Same as C1	
C14	Same as C4	
C15	Same as C12	
C16	CAPACITOR, Fixed, Paper Dielectric; .05 uf ±20%, 400 vdc	
C17	Same as C2	
C18	Same as C6	
C19	Not used	
C20	CAPACITOR, Fixed, Mica Dielectric; 5100 uuf, ±5%, 500 vdc	
C21	Same as C16	
C22	CAPACITOR, Fixed, Paper Dielectric; 1 uf, ±10%, 200 vdc	
C23	Same as C20	
C24	Same as C16	
C25	Same as C1	
C26	Same as C12	
C27	Same as C2	
C28	CAPACITOR, Fixed, Mica Dielectric; 1000 uuf ±10%, 500 vdc	
C29	CAPACITOR, Fixed, Paper Dielectric; .25 uf ±10%, 600 vdc	
C30	Same as C9	
C31	Not used	
C32	Same as C8	
C33	CAPACITOR, Fixed, Mica Dielectric; 220 uuf ±10%, 500 vdc	
C34	Same as C2	
C35	Same as C9	
C36	Same as C2	
C37	Same as C33	
C38, C39	Not used	
C40	Same as C2	

Reference Designation	Description	Polarad Part No.
C41	CAPACITOR, Fixed, Mica Dielectric; .01 uf, 1200 vdc	CD4-21010
C42	Same as C9	
C43, C44	Same as C1	
C45	CAPACITOR, Fixed, Paper Dielectric; .25 uf, 1000 vdc	
C46 to C54	Not used	
C55	CAPACITOR, Fixed, Paper Dielectric; 2 uf, 1500 v	
C56	CAPACITOR, Fixed, Paper Dielectric; 8 uf, 1500 v	
C57	Same as C2	
C58	CAPACITOR, Fixed, Paper Dielectric; .5 uf, 600 v	
C59	CAPACITOR, Fixed, Paper Dielectric; .5 uf, 1000 v	
C60	Same as C2	
C61	CAPACITOR, Fixed, Paper Dielectric; 1 uf ±10%, 600 v	
C62 to C70	Not used	
C71	Same as C2	
C72 to C80	Not used	
C81, C82	CAPACITOR, Fixed, Paper Dielectric; 4 uf, 1000 v	
C83	Same as C2	
C84	Same as C9	
CR1 to CR5	SEMI CONDUCTOR DEVICE DIODE, 1N69	
F1, F2	FUSE; 5 amp, 250 v	
I1	FREQUENCY DIAL INDICATOR; no. 47 bulb and bayonet socket	
I2	PILOT LIGHT ASSEMBLY; Dial Light H-8-1930-121 w/grounding lug, lamp 328	
J1	CONNECTOR, Receptacle, Electrical; BNC type, UG-625B/U	
J2	CONNECTOR, Receptacle, Electrical; 11 female contacts, w/ adapter plate and spring	B14201-1
J3	CONNECTOR, Receptacle, Electrical; BNC type, UG-625/U	
J4	CONNECTOR, Receptacle, Electrical; BNC type, UG-262/U	
J5	Same as J1	
J6	Same as J4	
J7	Same as J1	
J8	Same as J4	
J9	Same as J1	
J10	Same as J4	
J11	CONNECTOR, Receptacle, Electrical; 15 contacts, female	BK5369-S-15
J12	Not used	
J13	CONNECTOR, Fixed, rf output	AK5401
J14	CONNECTOR, Receptacle, Electrical; (Hubbell 7486)	
J15	Not used	
J16	CONNECTOR, Receptacle, Electrical; 21 female contacts	B537230
K1	RELAY-DELAY; 11560 sec. S.P.S.T. (Amperite, 155N060T)	
K2	HOLD RELAY: DPDT, contact arrangements, 6, A.C., 115 v	BP12644
L1, L2	CHOKE, Filter, 60 uh, rf coil form	AP-13011
L3, L4	Not used	
L5	CHOKE, Filter, 15 H, 60 ma	B124339
L6	CHOKE, Filter; 10 H, 175 ma	B124340
M1	AMMETER: w/mounting hardware	A101275
P1	CONNECTOR, Plug, Electrical; BNC type, UG-260/U	
P2	CONNECTOR, Plug, Electrical; 11 contacts	BP14200-1
P3	Same as P1	
P4	Not used	
P5	Same as P1	
P6	Not used	
P7	Same as P1	
P8	Not used	
P9	Same as P1	
P10	Not used	
P11	CONNECTOR, Plug, Electrical; 15 male contacts	B537008
P12 to P15	Not used	

Reference Designation	Description	Polarad Part No.
P16	CONNECTOR, Plug, Electrical; 21 male contacts	B537110
R1	RESISTOR, Fixed, Composition; 1 megohm ±10%, 1/2 w	
R2	RESISTOR, Fixed, Composition; 100 ohms ±10%, 1/2 w	
R3	RESISTOR, Fixed, Composition; 270 ohms ±10%, 1/2 w	
R4, R5, R6	RESISTOR, Fixed, Composition; 10,000 ohms ±10%, 2 w	
R7	RESISTOR, Fixed, Composition; 47,000 ohms ±10%, 1/2 w	
R8	RESISTOR, Fixed, Composition; 270,000 ohms ±10%, 1 w	
R9	RESISTOR, Fixed, Composition; 150,000 ohms ±10%, 1 w	
R10	RESISTOR, Fixed, Composition; 1,000 ohms ±10%, 1/2 w	
R11	Same as R7	
R12	Same as R4	
R13	RESISTOR, Fixed, Composition; 15,000 ohms ±10%, 1/2 w	
R14	RESISTOR, Fixed, Composition; 100,000 ohms ±10%, 1/2 w	
R15	RESISTOR, Fixed, Composition; 820,000 ohms ±10%, 1/2 w	
R16	Same as R14	
R17	RESISTOR, Variable; 50,000 ohms, ±20%, 2 watts	
R18	RESISTOR, Fixed, Composition; 15,000 ohms ±10%, 1 w	
R19, R20	Same as R2	
R21, R22, R23	RESISTOR, Fixed, Composition; 18,000 ohms ±10%, 2 w	
R24	RESISTOR, Fixed, Composition; 3300 ohms ±10%, 1/2 w	
R25	RESISTOR, Variable; 5,000 ohms ±20%, 2 watts	
R26	Same as R2	
R27	Same as R1	
R28	RESISTOR, Fixed, Composition; 470,000 ohms ±10%, 1/2 w	
R28***	RESISTOR, Fixed, Composition; 270,000 ohms ±10%, 1/2 w	
R29, R30***	RESISTOR, Variable; 2.5 megohm ±10%, 2 w	
R31	Same as R14	
R32	RESISTOR, Fixed, Composition; 390 ohms ±10%, 1/2 w	
R33	Same as R14	
R34	Same as R28	
R34***	Same as R28***	
R35	RESISTOR, Fixed, Composition; 820 ohms ±10%, 1/2 w	
R36	RESISTOR, Variable; 1 megohm ±20%, 2 w	
R37	RESISTOR, Fixed, Composition; 47,000 ohms ±10%, 1 w	
R38	RESISTOR, Fixed, Composition; 4700 ohms ±10%, 1/2 w	
R39	Not used	
R40	RESISTOR, Fixed, Composition; 10 ohms ±10%, 1 w	
R41	RESISTOR, Variable; three sections, 2 megohms ±20%, 25,000 ohms ±10%, 2 w	A23573
R42	RESISTOR, Fixed, Composition; 220,000 ohms ±10%, 1 w	
R43	RESISTOR, Variable; 2.5 megohms ±20%, 2 watts	
R44, R45	Same as R1	
R46, R47	Same as R2	
R48, R49	Same as R25	
R50	RESISTOR, Fixed, Composition; 5600 ohms ±10%, 1/2 w	
R51	Same as R32	
R52	Same as R14	
R53	Same as R15	
R54, R55	RESISTOR, Fixed, Composition; 3900 ohms ±10%, 2 w	
R56	RESISTOR, Fixed, Composition; 56 ohms ±10%, 1/2 w	
R57	Same as R28	
R58	Same as R36	
R59	RESISTOR, Fixed, Wire Wound; 4500 ohms ±10%, 10 w	
R60	Not used	
R61	Same as R14	
R62	RESISTOR, Fixed, Composition; 220,000 ohms ±10%, 1/2 w	
R63	Same as R14	
R64	Same as R10	

***Denotes the changes for the following equipment serial numbers: 146, 150, 155, 156, 159, 161, 167, 168, 170, 171, 172, 173, 175, 176, 177, 179, 181, 186, 187, 191 and 192.

Reference Designation	Description	Polarad Part No.
R65	RESISTOR, Variable; 5,000 ohms ±10%, 2 w, with switch s.p.d.t., see S7	A108102
R66, R67, R68	RESISTOR, Fixed, Composition; 3300 ohms ±10%, 2 w	
R69	Not used	
R70	Same as R56	
R71 to R74	Not used	
R75	RESISTOR, Fixed, Composition; 22 ohms ±10%, 1/2 w	
R76	Same as R1	
R77	Same as R10	
R78	Same as R37	
R79	Same as R76	
R80	RESISTOR, Fixed, Composition; 680 ohms ±10%, 1/2 w	
R81	Not used	
R82	RESISTOR, Fixed, Composition; 22,000 ohms ±10%, 2 w	
R83	RESISTOR, Fixed, Composition; 2700 ohms ±10%, 1 w	
R84	RESISTOR, Variable; 2500 ohms ±10%, 2 w	
R85, R86	Same as R14	
R87, R88	Same as R4	
R89	RESISTOR, Variable; 25,000 ohms ±10%, 2 w	
R90	Same as R89 *	
	** RESISTOR, Variable; 10,000 ohms ±10%, 2 w	
R91	Not used	
R92	RESISTOR, Variable; 50,000 ohms ±10%, 2 w *	
	RESISTOR, Variable; 100,000 ohms ±10%, 2 w **	
R93	Same as R89 *	
	** Same as R92 *	
R94	Same as R89 *	
	RESISTOR, Variable; 15,000 ohms ±10%, 2 w **	
R95	* Same as R94 **	
	RESISTOR, Variable; 10,000 ohms ±10%, 2 w **	
R96	RESISTOR, Variable; 100,000 ohms ±10%, 12 w	
R97	RESISTOR, Variable; 250,000 ohms ±10%, 2 w	
R98	Same as R89	
R99 to R101	Not used	
R102	RESISTOR, Fixed, Composition; 50 ohms ±10%, 1/2 w	A544104
R103, R104	Not used	
R105	RESISTOR, Fixed, Composition; 470,000 ohms ±10%, 2 w	
R106, R107	RESISTOR, Fixed, Composition; 330,000 ohms ±10%, 2 w	
R108	RESISTOR, Fixed, Composition; 120,000 ohms ±10%, 1 w	
R109	Same as R76	
R110	Same as R62	
R111	RESISTOR, Variable; 100,000 ohms ±10%, 2 w	
R112	Not used	
R113, R114	RESISTOR, Fixed, Composition; 56,000 ohms ±10%, 2 w	
R115	RESISTOR, Fixed, Composition; 56 ohms ±5%, 1/2 w	
R116	Not used	
R117	RESISTOR, Fixed, Wire Wound; 17,500 ohms ±10%, 10 w *	
	RESISTOR, Fixed, Wire Wound; 20,000 ohms ±10%, 10 w **	
R118, R119	RESISTOR, Fixed, Composition; 68,000 ohms ±10%, 2 w	
R120, R121	Not used	
R122	RESISTOR, Fixed, Composition; 27,000 ohms ±10%, 1 w	
R123, R124	RESISTOR, Fixed, Composition; 100 ohms ±10%, 1 w	
R125	Same as R32	
R126	Same as R77	
R127 to R133	Not used	
R134	RESISTOR, Fixed, Wire Wound; 3500 ohms ±10%, 25 w	
R135	RESISTOR, Fixed, Composition; 180,000 ohms ±10%, 1/2 w	
R136 to R180	Not used	
R181 to R182, R183	RESISTOR, Fixed, Composition; 33,000 ohms ±10%, 2 w	

* MSG-1 ** MSG-2A

Reference Designation	Description	Polarad Part No.
R184	RESISTOR, Fixed, Composition; 2.2 megohm ±10%, 1 w	
R185	RESISTOR, Fixed, Composition; 470,000 ohms ±10%, 1 w	
R186, R187	RESISTOR, Fixed, Composition; 2700 ohms ±10%, 2 w	
R188, R189	Same as R186	
R190	Same as R186	
R191	RESISTOR, Fixed, Composition; 470,000 ohms ±5%, 1/2 w	
R192	Same as R96	
R193	RESISTOR, Fixed, Composition; 120,000 ohms ±5%, 1/2 w	
R194, R195	RESISTOR, Fixed, Composition; 270 ohms ±10%, 2 w	
R196 to R201	Not used	
R202	RESISTOR, Variable; 5,000 ohms ±10%, 4 w	
R203	RESISTOR, Variable; 1,000 ohms ±20%, 2 watts	B530825
R204	Same as R123	
R205, R206	RESISTOR, Fixed, Film; 130 ohms ±1%, 1/2 w	
R207, R208	Same as R205	
R209	RESISTOR, Fixed, Composition; 220 ohms ±10%, 1/2 w *	
	RESISTOR, Fixed, Composition; 470 ohms ±10%, 1/2 w **	
R210	RESISTOR, Fixed, Composition; 1200 ohms ±10%, 2 w	
RT1	RESISTOR, Thermal; 2,000 ohms ±25%, bead type, temperature coefficient 3.4% at 25°C	AK5037
RT2	RESISTOR, Thermal; disc type, 725 ohms ±5%, -4.4% temperature coefficient	B510511
RT3	RESISTOR, Thermal; disc type, 760 ohms ±5%, -4.4% temperature coefficient	B510512
S1	SWITCH, Rotary; 12 positions	CP12492
S2	SWITCH, Rotary, 12 positions	CP23345
S3	SWITCH, Rotary; 12 positions, 4 ceramic wafers	CP23346
S4	SWITCH, Sensitive; 28 vdc, 115 vac, 60 cycles, 36 amp *	AP20438
S5	SWITCH, Toggle; spdt	
S6	Not used	
S7	SWITCH, spdt p/o R65	
TB5	TERMINAL BOARD; 5 connections	BP23334
TB6	TERMINAL BOARD; 5 connections	BP23337
TP1	JACK, Tip	AP18398-1
TP2	JACK, Tip	A514202
TP3	JACK, Tip	A514203
T1	TRANSFORMER, Pulse	A106204
T2	TRANSFORMER, Pulse	A106203
T3	Same as T1	
T4	Not used	
T5	TRANSFORMER, Filament	B105075
T6	TRANSFORMER, Anode	B105074
T7, T8	Not used	
T9	TRANSFORMER, Power	B105073
V1	ELECTRON TUBE, 12AT7	
V2 to V7	Same as V1	
V8, V9	ELECTRON TUBE, 6AK6	
V10	ELECTRON TUBE, 6AU6	
V11	Same as V1	
V12	ELECTRON TUBE, 6X4	
V13	ELECTRON TUBE, 5837 *	
	ELECTRON TUBE, 5836 **	
V14	ELECTRON TUBE, 5R4GY	
V15	ELECTRON TUBE, 6AR6	
V16	Same as V10	
V17	ELECTRON TUBE, 0A2	
V18	ELECTRON TUBE, 0B2	
V19	Same as V17	

* MSG-1 ** MSG-2A

Reference Designation	Description	Polarad Part No.
V20	Same as V18 *	
	Same as V17 **	
V21	Same as V1	
V22	Same as V1	
V23	Not used	
V24	ELECTRON TUBE, 5651	
V25 to V29	Not used	
V30	Same as V18	
V31 to V33	Not used	
V34	Same as V14	
V35	Same as V10	
V36	Same as V18	
V37	ELECTRON TUBE, 6AS7G	
W1 to W5	COAXIAL CABLE, RG-71/U	

* MSG-1 ** MSG-2

POLARAD ELECTRONICS CORP.

CONSULTANTS — DESIGNERS — MANUFACTURERS

43-20 34th Street Long Island City 1, N. Y.

EXeter 2-4500

REQUEST FOR MAINTENANCE

FROM:

COMPANY NAME _____ DATE: _____

ADDRESS: _____ INDIVIDUAL _____

_____ POSITION _____

SECTION OR DIVISION _____ PHONE NO. _____ EXT. _____

_____

EQUIPMENT _____ DATE OF PURCHASE _____

MODEL _____ SERIAL NO. _____ ORDER NO. _____

_____

TROUBLE REPORT:

A. Description of trouble _____

_____

_____

_____

_____

_____

B. Has trouble been localized? _____ If so, how and where: _____

_____

_____

_____

_____

_____

Manufacturers of Microwave & Electronic Equipment